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NUARY 1959

PHYSICS ABSTRACTS

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SECTION A OF SCIENCE ABSTRACTS

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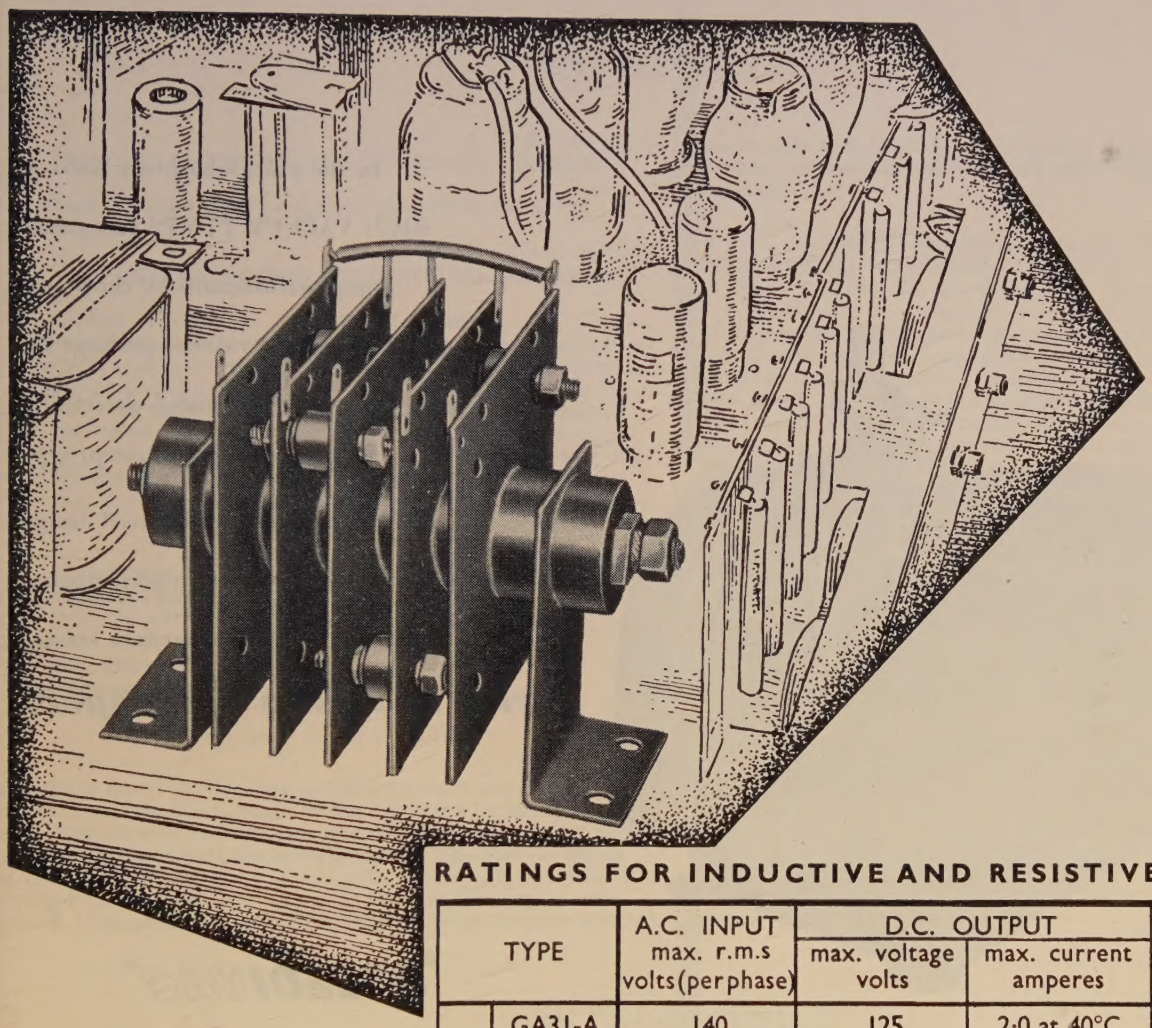

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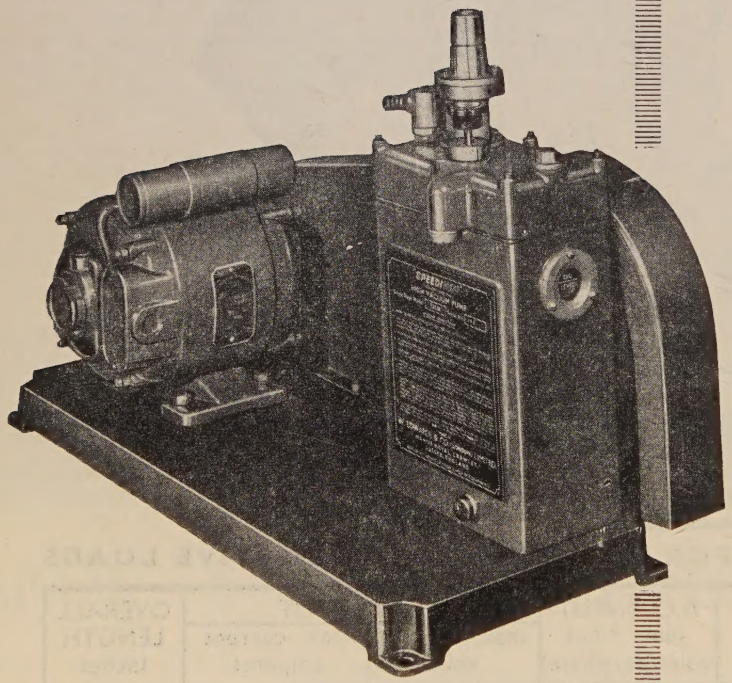

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PHYSICS ABSTRACTS

Volume 62 JANUARY 1959 Number 733

MATHEMATICS

517.4 : 538.3

1. SCALAR–VECTOR ANALOG OF GREEN'S THEOREM.
H.Unz.
I.R.E. Trans Antennas and Propagation, Vol. AP-6, No. 3, 300 (July, 1958).

517.5 : 530.145

2. EXPLICIT EXPRESSION FOR SPHERICAL HARMONICS.
L.A.Schmid.
Amer. J. Phys., Vol. 26, No. 7, 485-9 (Oct., 1958).

A general expression for spherical harmonics as an explicit function of the angle coordinates is derived using standard methods of group-representation theory. This expression is useful for two reasons: (1) its normalization is the one most commonly used by physicists, rather than one of several other normalization conventions used mainly by mathematicians; (2) its form is especially convenient for use in the operator equations which occur in quantum mechanics. A set of relations useful in solving the Dirac equation are listed.

517.9

3. CONSTRUCTION OF THE CLOSED-FORM SOLUTION OF THE LINEAR INTEGRAL EQUATION WITH CONSTANT COEFFICIENTS AND A PERIODIC RIGHT-HAND SIDE TERM.
O.Koníček.
Slaboproudý Obzor, Vol. 19, No. 6, 397-402 (1958). In Czech.

The equation considered is in the form

$$a_0 y + a_1 \int_0^t y(\tau)d\tau + a_2 = f(t),$$

where f(t) is a periodic function having a period T and $a_0 a_1 \neq 0$. The solution of the equation is based on the use of the Laplace transforms. The unknown function y(t) is found by assuming that it should also be periodic and have the same period T. The function y(t) is then expressed as a sum of $y_1(t)$ and $y_2(t)$, where $y_1(t)$ represents the the periodic component (over intervals equal to T) and $y_2(t)$ is the transient. The advantage of this method lies in the fact that it avoids the Fourier analysis of f(t). The method is illustrated by means of a numerical example and compared with the standard Fourier-series approach. R.S.Sidorowicz

517.9 : 530.145

5. ON THE INVARIANT AND CAUSAL SOLUTIONS OF THE DIFFERENTIAL EQUATIONS $(\Box \mp \kappa^2)\psi(r,t) = \delta^4(r,t)$. H.Schmidt.
Z. Phys., Vol. 151, No. 3, 365-74 (1958). In German.

Solutions of $(\Box - \kappa^2)\psi(r,t) = \delta^4(r,t)$ were investigated because of their great importance in wave mechanics; solutions of the complementary function are given and some methods of finding the particular integral outlined. Similar methods are applied to $(\Box + \kappa^2)\psi(r,t) = \delta^4(r,t)$ on the hypothesis that the solution is to be invariant to the Lorentz transformation. It is shown that there are causal, or retarded, solutions of this equation which do not imply that an event can precede its cause, and which may correspond to physical reality in a case where the group velocity of the wave exceeds that of light. Further investigation of this equation is required. N.Corcoran

517.9

4. CONSTRUCTION OF THE CLOSED-FORM SOLUTION OF THE LINEAR INTEGRAL EQUATION WITH CONSTANT COEFFICIENTS AND ANTI-PERIODIC RIGHT-HAND-SIDE TERM.
O.Koníček.
Slaboproudý Obzor, Vol. 19, No. 8, 550-5 (1958). In Czech.

The work is a continuation and a corollary of the author's previous paper (see preceding abstract), where a general solution of the linear integral equation was derived. Here, it is assumed that right-hand-side term f(t) is such that f(t-T) = −f(t), where T is half the period of f(t). It is shown that for this case the solution can be considerably simplified. The results are stated in three theorems and the method of solution is illustrated by three practical examples. It is also shown that some complex periodic functions can be split into an anti-periodic component and a simple periodic function; by adopting this technique it is possible to solve complex integral equations. R.S.Sidorowicz

ASTROPHYSICS

522.615

6. AN AIRBORNE INFRA-RED SOLAR SPECTROMETER.
J.T.Houghton, T.S.Moss and J.P.Chamberlain.
J. sci. Instrum., Vol. 35, No. 9, 329-33 (Sept., 1958).

A grating spectrometer developed for installation in a Canberra aircraft is described. An electronically operated heliostat maintains an image of the sun on the entrance slit. Resolution of 2 cm^{-1} is achieved with a lead sulphide detector. Preliminary results are given for the 2 μ region for heights up to 45 000 ft.

523.11

7. FREQUENCIES OF STARS WITH VARIOUS CHEMICAL COMPOSITION. S.von Hoerner.
Astrophys. J., Vol. 126, No. 3, 592-5 (Nov., 1957).

According to current theories the chemical composition of a main-sequence star should be a function of the time when the star was created. A series of assumptions leads to a contrary result. Perhaps the most crucial is that the variation of the rate of star formation is slow compared with the mean time of release of matter, from stellar to interstellar. Values of this time (based upon a result in Z. Astrophys., Vol. 42, No. 4, 273-88, 1957) are given for various values of the exponent in the assumed mass distribution function. G.A.Chisnall

523.5

8. LEAD FROM SOME STONE METEORITES.
R.R.Marshall and D.C.Hess.
J. chem. Phys., Vol. 28, No. 6, 1258–9 (June, 1958).

Lead concentrations in stone meteorites were determined by volatilization. Although they are no more than one tenth to a few tenths of a p.p.m., they have been found to be 1.5 to 3 times as much as should be present according to the measured uranium concentrations. The lead–lead ages deduced from the isotopic compositions of two meteorites are both 4.7×10^9 yr. R.Schnurmann

523.75 : 536.711

9. ON THE POSSIBILITY OF EXPANSION AND SHOCK FLOW IN PROMINENCES. U.Ericsson.
Ark. Astron., Vol. 2, Paper 9, 97-102 (1956).

The results of a detailed calculation of an adiabatic expansion of hydrogen are given and applied to a plane expansion flow with a covering shock wave. At the pressure of 0.06 dynes/cm^2 the interface between the cooled expanding gas, with a temperature of 1700°K, and the heated shock, with a temperature of 6000°K, has the velocity 40 km/sec and thus shows some characteristics of the two-temperature model of prominences suggested by Ohman (Abstr. 34/1957). Extrapolation to zero temperature in the expanding gas gives a higher vacuum velocity than that found for polytropic gases.

523.77

10. X-RAY AND ULTRAVIOLET EMISSION OF SOLAR FLARES (IGY PROJECT 10.3).
H.Friedman, T.A.Chubb, J.E.Kupperian, Jr, R.W.Kreplin and J.C.Lindsay.
Ann. Geophys., Vol. 14, No. 2, 232-5 (1958).

523.77

11. STUDIES OF SOME INFRARED FRAUNHOFER LINES.
G.Godoli.
Canad. J. Phys., Vol. 36, No. 4, 431-7 (April, 1958).

The apparatus function of the Dominion Observatory (Canada) solar infrared spectrometer was determined by laboratory observations of the CH_4 band at 1.7μ and checked by observations of the telluric CO_2 band at 1.6μ. The equivalent widths and the profiles of four Fe solar lines in the 1.6μ region were determined with the same instrument at seven different points on the solar radius. The equivalent widths agree better with those determined by Pagel than with those determined by Mohler. The profiles, corrected for the apparatus function, suggest a very high ratio γ/γ_{el} and a dependence of the kinetic temperature on the line strength.

523.775

12. SPECTROPHOTOMETRY OF INTENSE CHROMOSPHERIC EMISSION LINES. III. THE 5876 He I LINE. R.Michard.
Ann. Astrophys., Vol. 20, No. 1, 1-9 (1957). In French.

For previous work, see Abstr. 4786 (1956). Central intensities, profiles and total intensities of the He I D_3 line were measured on spectra photographed at the Arcetri solar tower under excellent "seeing" conditions. Unlike the H_α and H_β emissions, the D_3 line shows no fine structure indicative of spicule formation at chromospheric heights up to at least 5000 km, thus contradicting the results of Athay and Roberts (Abstr. 5193/1955). D.R.Barber

523.775

13. INTERPRETATION OF THE CHROMOSPHERIC Hα LINE. R.Michard.
C.R. Acad. Sci. (Paris), Vol. 247, No. 14, 990-2 (Oct. 6, 1958).
In French.

From an analysis of the profiles of Hα lines in high-dispersion chromospheric spectra it appears likely that the solar spicules originate in the lower chromosphere, occupying a small volume (~6%) of the chromospheric material at heights of between 1000 and 3000 km. About 85% of all spicules observed disappear around 4000 to 5000 km at a level where the chromospheric temperature is enhanced suddenly, and the coronal emission lines appear. D.R.Barber

525.3

14. THE ROTATION OF THE FIRST RUSSIAN EARTH-SATELLITE. J.H.Thomson.
Phil. Mag. (Eighth Ser.), Vol. 3, 912-16 (Aug., 1958).

Records of fading during morning and evening transits over Cambridge, England, at heights of about 500 and 200 km, respectively, are examined and discussed. The satellite was rotating at 6.5 rev per min, and the plane of polarization of the received radiation was rotated by the ionospheric Faraday effect. The observations indicated a rotation about the axis of symmetry, the direction of rotation being maintained constant throughout each orbital revolution. D.R.Barber

526.77 : 550.831

15. THE SEA GRAVIMETER. A.Graf.
Z. InstrumKde, Vol. 66, No. 8, 151-61 (Aug., 1958). In German.

Concludes that measurements are best made in suspended test chambers, where motion of the ship or submarine can be arranged to have no effect on the result. The value of "g" is deduced from the vertical oscillations of a mass at the end of a stiff horizontal rod, and all experimental precautions are taken to ensure that the oscillations are purely vertical, that they are in a region where the restoring force is truly proportional to the displacement, and that no other factor disturbs the results. Measurements were made in lakes, canals and the open sea, and consistent results obtained when the same route was traversed in the opposite direction. Corrections were applied (Eötvös, first order, and Browne, second order). The main constructional details of the apparatus are given, together with the results from test runs. N.Corcoran

PHYSICS

GENERAL

530.1

16. MIGHT PERHAPS ENERGY BE A MERELY STATISTICAL CONCEPT? E.Schrödinger.
Nuovo Cimento, Vol. 9, No. 1, 162-70 (July 1, 1958).

Arguments are given in favour of the opinion that the quantum-mechanical frequency, multiplied by Planck's constant, has for microscopic systems not the meaning of energy. It is suggested, that the concept of energy and its conservation, just like that of entropy and its increase, has merely a statistical meaning, the energy of a macroscopic system being the product of Planck's constant and a weighted average of the frequencies in question. The wide-spread attitude that the claim for an objective description of physical reality must be given up, is rejected on the ground that the so-called external world is built up exclusively of elements of single minds, and is characterized as what is common to all, recognized by every healthy and sane person. Hence the demand for a non-subjective description is inevitable, of course without prejudice whether it be deterministic or otherwise.

530.1

17. ON POSSIBLE REALIZATIONS OF MACH'S PROGRAM. F.A.Kaempffer.
Canad. J. Phys., Vol. 36, No. 2, 151-9 (Feb., 1958).

By "Mach's Programme" is meant the intention to understand all inertial effects as being caused by gravitational interaction. Within the framework of a simplified theory of gravitation, based upon ideas by Hund and Sciama, it is easy to invent primitive cosmological models for which Mach's Programme is realized. In particular, it is possible to understand the inertia of a linearly accelerated body as being due to radiative gravitational interaction with all other masses in the universe. If it is true that anti-matter has negative gravitational mass, as has been suggested by Morrison and Gold, then one may look upon Newton's second law as a manifestation of the preponderance of matter over anti-matter in the universe.

530.11

18. THE PROTON COMPTON WAVELENGTH AS THE "QUANTUM" OF LENGTH. L.S.Levitt.
Experientia, Vol. 14, No. 7, 233-4 (1958).

Many experimentally measured lengths in nuclear physics (effective ranges, scattering lengths, etc.) are close to integral multiples of the proton Compton wavelength. This is suggested as evidence for the existence of a fundamental length.

GRAVITATION. RELATIVITY

530.12

19. THE HODOGRAPH FOR THE MOTION OF A MATERIAL POINT IN RELATIVISTIC MECHANICS. M.Zăgănescu.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 6-8, 424-8 (1958).
In German.

The hodograph equations are derived for the two-dimensional motion of a particle in the special theory of relativity. The case of motion in a uniform field is discussed in detail. R.A.Newing

530.12

20. THE HYPOTHESIS OF THE GRAVITATIONAL EFFECT OF SPIN. O.Costa de Beauregard.
C.R. Acad. Sci. (Paris), Vol. 247, No. 15, 1092-4 (Oct. 13, 1958).
In French.

It is suggested, in common with several other authors, that the appearance of an energy-momentum vector oblique to the four-velocity corresponds to that of spin, pointing to the existence of a gravitational spin effect which, if it exists, may be studied experimentally. The antisymmetric part of the inertia tensor is related to the divergence of a spin density tensor, which is assumed to be completely antisymmetric, whence it follows that the energy-

momentum vector has a component transverse to the four-velocity. The usual relation between the inertia tensor and the gravitational potential then implies that the latter also has an antisymmetric part corresponding to a "spin gravitational field". A few remarks are made regarding these conclusions in relation to the unified field theory of gravitation and electromagnetism. T.R.Carson

530.12

21. THEORETICAL GRAVITY INSIDE MASSES. F.Gassmann.
Mitt. Inst. Geophys. E.T.H. Zurich, No. 32, 28-40 (July, 1957). In German.

Deals with theoretical gravity outside the earth, the attraction of the atmosphere being taken into account, and with theoretical gravity inside the earth. The theoretical earth is assumed to be a sphere of concentric structure and the effect of the rotation of the earth is neglected (spherical gravity). A formulae is given in orthogonal coordinates based on an ellipsoid of rotation. The concept of "normal shells" is introduced. Such a shell is bounded by two confocal ellipsoidal surfaces of rotation, and a density is assumed such that the exterior surface is an equipotential one, and that the attraction in the cavity vanishes. The atmosphere is assumed to be a "normal shell" and its influence on the normal free air gravity is computed. Theoretical gravity in the interior of the earth is defined by assuming that the earth is composed of a homogeneous ellipsoid and a normal shell extending from the surface down to a suitable depth.

530.12

22. ON THE INFLUENCE OF THE ROTATION OF THE CENTRAL BODY ON THE MOTION OF SATELLITES ACCORDING TO EINSTEIN'S THEORY OF GRAVITATION. N.St.Kalitzin.
Nuovo Cimento, Vol. 9, No. 3, 365-74 (Aug. 1, 1958). In German.

The relativistic equations of motion in the v^2/c^2 approximation are solved, and an expression for perihelion precession is derived. The term arising from the rotation of the central body agrees with that derived by the Lense–Thirring perturbation procedure only when the satellite moves in the equatorial plane of the central body; the difference for inclined satellite orbits arises from the fact that, in the present paper, the perihelion shift is measured in the plane of the satellite orbit. The calculation procedure does not depend on the smallness of the effects discussed and can be extended to the case of satellites with non-negligible mass. R.A.Newing

530.12

23. PAST–FUTURE ASYMMETRY OF THE GRAVITATIONAL FIELD OF A POINT PARTICLE. D.Finkelstein.
Phys. Rev., Vol. 110, No. 4, 965-7 (May 15, 1958).

The analytic extension of the Schwarzschild exterior solution is given in a closed form valid throughout empty space–time and possessing no irregularities except that at the origin. The gravitational field of a spherical point particle is then seen not to be invariant under time reversal for any admissible choice of time coordinate. The Schwarzschild surface r = 2m is not a singularity but acts as a perfect unidirectional membrane: causal influences can cross it but only in one direction. The apparent violation of the principle of sufficient reason seems similar to that which is associated with instabilities in other nonlinear phenomena.

530.12 : 535.1

24. ON THE PROPAGATION OF LIGHT IN A GRAVITATIONAL FIELD. M.Kohler.
Optik, Vol. 14, No. 10, 433-6 (Oct., 1957). In German.

An affine parameter of a null-geodesic implies that two line elements of the same geodesic have an invariant ratio "length". In the flat space-time of special relativity each time coordinate of a rectilinear coordinate system is an affine parameter. The calculation of the affine parameter is performed for a number of curved spaces. F.Ansbacher

530.12

25. ON THE STABILITY OF THE NORDSTRÖM REISSNER SINGULARITY. L.Favella.
Nuovo Cimento, Vol. 9, No. 2, 362-4 (July 16, 1958).

The stability of the Nordström–Reissner metric representing a distribution of mass and electric charge is proved for small non-spherical perturbations. G.Stephenson

530.12

26. ON THE LOCALIZATION OF THE ENERGY OF A PHYSICAL SYSTEM IN THE GENERAL THEORY OF RELATIVITY. C.Møller.
Ann. Phys (New York), Vol. 4, No. 4, 347-71 (Aug., 1958).

A consistent expression for the energy density of an arbitrary physical system is given inside the framework of the general theory of relativity: it is thus possible to give a physical meaning to the localization of the energy in gravitational fields. For the total energy of closed physical systems, the new formulation gives the same values as the current theory, but the restriction to quasi-Galilean coordinates is no longer necessary. Also, it is possible to give a unique meaning to the energy content in any part of a system, as well as to the total energy of a closed universe. The energy conservation law is written in a differential form analogous to Poynting's theorem in electrodynamics. It is of importance in the discussion of the problem of the existence of energy carrying gravitational waves.

530.12

27. VARIATIONAL EQUATIONS OF GENERAL RELATIVITY. É.Blancheton.
C.R. Acad. Sci. (Paris), Vol. 247, No. 4, 420-2 (July 28, 1958). In French.

Given a stationary gravitational field inside a world tube S, it is shown that the field on the surface of S defines an exterior field which must have singularities within S. The theorem is extended to the Jordan–Thiry unified theory. R.A.Newing

530.12

28. COMPARISON OF THE TWO METHODS OF OBTAINING THE EQUATIONS OF MOTION IN GENERAL RELATIVITY. T.H.Pham.
Nuovo Cimento, Vol. 9, No. 4, 647-63 (Aug. 16, 1958). In French.

Starting from the field equations, the equations of motion of a system of bodies are deduced in two ways, according to whether one uses the Einstein equations for the internal or for the external case. The first method utilizes the conservation properties of the energy-momentum tensor corresponding either to a system of masses or to a perfect fluid. The second method makes use of a representation of the matter as singularities of the external field. The connection between the two approaches is established by observing the relations between the energy-momentum tensor and the discontinuities of the Einstein tensor. Using Stokes' theorem, the two methods are shown to be equivalent. T.R.Carson

530.12

29. ON LINEAR FIELD THEORY. V. W.Scherrer.
Z. Phys., Vol. 152, No. 3, 319-27 (1958). In German.

For Pt IV, see Abstr. 4173 (1956). An action principle is set up which contains also antisymmetrical invariants. If the characteristic universal numerical constants of the antisymmetric terms are put equal to zero, then one obtains ten symmetrical equations, which are identical with Einstein's gravitational equations, and the remaining six antisymmetrical equations are of the first order. These latter "matter-equations" are discussed. P.Roman

FIELD THEORY. QUANTUM THEORY

530.145 : 539.165

30. TESTS FOR TIME REVERSAL INVARIANCE AND FEYNMAN–GELL-MANN THEORY IN ALLOWED BETA TRANSITIONS. B.Kuchowicz.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 6, 395-401 (1958).

Experiments are suggested in which the electron–neutrino angular correlation and electron polarization are to be measured simultaneously (see Abstr. 507/1958). J.C.Taylor

530.145

31. CHIRALITY. L.L.Whyte.
Nature (London), Vol. 182, 198 (July 19, 1958).

A definition of this word is proposed. J.C.Taylor

530.145

32. THE ANALYTIC PROPERTIES OF THE VACUUM EXPECTATION VALUE OF A PRODUCT OF THREE SCALAR LOCAL FIELDS. G.Källén and A.Wightman.
K. Danske Vidensk. Selsk. mat.-fys. Skr., Vol. 1, No. 6, 58 pp. (1958).

From the general requirements of Lorentz invariance, reasonable mass spectrum shape, and local commutativity, it follows that the vacuum expectation value of a product of field operators is the boundary value of an analytic function. A corresponding statement

holds for the Fourier transform of the retarded commutator and for the time-ordered product of the fields. For the special case of three scalar fields, it is shown that, in general, the domains of analyticity obtained in x-space and in p-space are identical. This domain is explicitly computed and shown to be bounded by pieces of analytic hypersurfaces. These surfaces intersect in corners which are of such a kind that the domain is not a natural domain of analyticity. The holomorphic envelope of this domain is computed using only elementary methods. The result turns out also to be bounded by pieces of analytic hypersurfaces.

530.145

33. TEST ON THE GLOBAL SYMMETRY.
D.Ito, S.Minami and H.Tanaka.
Nuovo Cimento, Vol. 9, No. 3, 554-5 (Aug. 1, 1958).

A typical test proposed depends upon looking for a counterpart of the (3/2, 3/2) resonance in the final $\Lambda-\pi$ system of the reaction $K^- + D \rightarrow \Lambda^0 + p + \pi^-$. J.C.Taylor

530.145

34. CAUSALITY AND VACUUM POLARIZATION DUE TO A CONSTANT AND A RADIATION FIELD. A.Minguzzi.
Nuovo Cimento, Vol. 9, No. 1, 145-53 (July 1, 1958).

It is shown that the modification of the vacuum due to the superposition of a constant electromagnetic field and a radiation field can be accounted for by a refraction index which is the limit to the real axis from the upper part of the complex plane of a function of the frequency analytic in the full complex plane with exception of branch points on the real axis. This function is explicitly constructed. It is shown that when the absorption is negligible, the phase velocity of the radiation field in the constant electromagnetic field region is smaller than the light velocity in vacuo.

530.145

35. NUCLEON PROPAGATORS. I-II. L.M.Garrido Arilla.
An. Real. Soc. Espan. Fiz. Quim., Vol. 54(A), No. 5-6, 143-60, 161-2 (May-June, 1958). In Spanish.

530.145

36. TIME-INDEPENDENT NONRELATIVISTIC COLLISION THEORY. E.Gerjuoy.
Ann. Phys. (New York), Vol. 5, No. 1, 58-93 (Sept., 1958).

Arbitrarily complicated rearrangement collisions describable by the time-independent non-relativistic Schrödinger equation are treated in a wholly time-independent framework, without explicit reference to transition probabilities. Introducing a generalized probability current operator for many-particle systems, the current flow at large distances can be computed in complete analogy with one-particle scattering. This procedure leads to the same formal expressions for reaction rates as are obtained from more conventional formulations; it is an immediate consequence of the asymptotic behaviour of the Green's function that the matrix elements

$$\Psi_f^{(-)*} V_i \psi_i = \psi_f^* V_f \Psi_i^{(+)}$$

yield the scattering amplitude $A(i \rightarrow f)$, and that $\Psi_f^{(-)}$ is a solution with incoming scattered waves. Moreover the time-independent formulation avoids perplexities associated with the necessity for computing transition probabilities from projections on sets of non-orthogonal states. In the reaction $a + b \rightarrow c + d + e$ for instance it turns out automatically, without projecting the solutions on plane-wave states, that coincidences are observed in counters placed at large distances, r_c, r_d, r_e only when r_c, r_d, r_e are in the ratios of the classical velocities of c, d, e; here c, d, e are a rearrangement of the particles contained in a, b. These procedures can be applied either in the laboratory or centre-of-mass systems; eliminating the centre-of-mass coordinates does not simplify the calculations for three-body breakup $ab \rightarrow cde$. Reciprocity relations for two and three-body breakup are examined, and mathematical difficulties of this time-independent formulation are discussed.

530.145

37. ON THE WEAK INTERACTIONS OF ELEMENTARY PARTICLES. W.Królikowski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 6, 417-21 (1958).

Assuming a singlet neutral pion to exist, and assigning isotopic spin to leptons, a possible conservation rule for the weak interactions is suggested. J.C.Taylor

530.145

38. AN EXTENSION OF THE INTERMEDIATE COUPLING METHOD OF TOMONAGA. J.Mandelbrojt.
C.R Acad. Sci. (Paris), Vol. 247, No. 10, 780-2 (Sept. 8); No. 11, 808-9 (Sept. 15, 1958). In French.

Tomonaga's variational method for intermediate coupling (Abstr.2981/1949) is improved by extending the class of state vectors used as trial functions. The method of extension can be iterated and gives a series of energies and state vectors tending to those of the true ground state. G.P.McCauley

530.145

39. A METHOD FOR THE STUDY OF THE VALIDITY OF TOMONAGA'S INTERMEDIATE COUPLING METHOD.
J.Mandelbrojt.
C.R. Acad. Sci. (Paris), Vol. 247, No. 13, 915-17 (Sept. 29, 1958). In French.

The validity of Tomonaga's approximation is studied with the help of an inequality due to Weinstein (Abstr. 4444/1934). Two applications are given: the neutral scalar meson, where Tomonaga's result is exact; and the charged symmetric case, where Tomonaga's approximation becomes exact when the coupling constant goes to infinity. J.Lascoux

530.145

40. UNITARY TRANSFORMATIONS OF SYMMETRIC PS–PS AND PS–PV INTERACTIONS. J.S.R.Chisholm and G.M.Dixon.
Nuovo Cimento, Vol. 9, No. 1, 125-35 (July 1, 1958).

Exact covariant unitary transformations applied to the Lagrangians of symmetric PS–PS and PS–PV theories exhibit the so-called "equivalence" of the pseudoscalar and pseudovector couplings. The transformation of the PS–PS theory is compared with similar transformations. The value of making unitary transformations is discussed, and some remarks on renormalization problems are made.

530.145

41. PROCA'S EQUATION [FOR SPIN-1 PARTICLES] IN SPHERICAL COORDINATES. S.W.Mac-Dowell.
An. Acad. Brasil. Cienc., Vol. 27, No. 3, 279-84 (1955). In Spanish.

530.145

42. A THEORY OF PARTICLES OF SPIN ONE-HALF.
A.O.Barut.
Ann. Phys. (New York), Vol. 5, No. 2, 95-105 (Oct., 1958).

From the two-component second order fermion theory of Feynman and Gell-Mann a four component theory of spin-$\frac{1}{2}$ particles in Hamiltonian form is derived. When a suitable indefinite metric is introduced in the spin space by means of charge density the spin,as well as the charge degrees of freedom,may be separated. Spin and angular momentum are separately constants of the motion which is not the case for the Dirac equation. If states with positive norm describe particles the states of the corresponding charge conjugate particles have negative norm. The Hamiltonian is quadratic in the momenta which allows a straightforward transition to the nonrelativistic Pauli equation. The law of transformation of the wave function under the Lorentz transformations is given, and the relation and equivalence of the theory to Dirac and Foldy–Wouthuysen equations is established.

530.145

43. TWO THEOREMS CONCERNING THE FIELD EQUATIONS IN THE SPINOR SPACE. J.Rzewuski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 5, 335-41 (1958).

By "spinor space" is meant a space in which the coordinates transform like spinors. This paper is about the analogues of the Dirac and Klein-Gordon equations in such a space. J.C.Taylor

530.145 : 539.12

44. ON PARTICLE NOMENCLATURE. L. de Broglie.
C.R. Acad. Sci. (Paris), Vol. 247, No. 15, 1069-72 (Oct. 13, 1958). In French.

A classification of, and set of internal quantum numbers for, elementary particles is suggested, based on the idea that all particles are compounds of spin $\frac{1}{2}$ particles. J.C.Taylor

530.145

45. ON THE PHYSICAL PICTURE OF PARTICLES WITH INTEGRAL SPIN. M.Bunge.
Cienc. e Invest., Vol. 14, No. 7, 311-15 (July, 1958). In Spanish.

Within the framework of Kemmer's theory, a position operator is defined $X = x - (1/K)\beta$ (with the usual notations). One can then establish a semiclassical relation between momentum and velocity, and introduce six new constants of motion, analogous to classical angular momentum. L.Pincherle

530.145

46. INVERSE β-PROCESSES AND NONCONSERVATION OF LEPTON CHARGE. B.Pontekorvo.
Zh. éksper. teor. Fiz., Vol. 34, No. 1, 247-9 (1958). In Russian.

The consequences of viewing the neutrino to be a "mixed particle", i.e. a linear combination of charge conjugation eigenstates, are considered. In particular, the neutrino can change into an antineutrino in the vacuum. G.E.Brown

530.145

47. POLARISATION EFFECTS IN ELASTIC SCATTERING OF DIRAC ELECTRONS BY SCREENED COULOMB FIELD. H.Banerjee.
Acta phys. Austriaca, Vol. 12, No. 1, 70-83 (1958).

The polarization-dependent cross-section for scattering of Dirac electrons by a screened Coulomb field is calculated in the covariant S-matrix formalism. The first contribution to the asymmetry factor $a(\theta)$ appear only in the second Born approximation of the external field. The effect of screening is found to be small except at small angles and low energy scattering. Detailed analyses of the results are given for three cases: when the incident beam is (a) unpolarized, (b) longitudinally polarized, and (c) transversely polarized. Applications to double and triple scattering experiments are considered and expressions for the asymmetry ratio δ obtained for these cases. Results of recent double scattering experiments with longitudinally polarized electron beams are found to compare favourably with the theoretical results obtained in this paper.

530.145

48. ON THE ISOBARS OF THE NUCLEON IN THE FIXED-SOURCE THEORY. W.Królikowski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 6, 413-16 (1958).

A generalization of the standard work of Pauli and Dancoff (Abstr. 3089/1942). J.C.Taylor

530.145

49. ON THE INTRODUCTION OF "CLOTHED" OPERATORS IN QUANTUM FIELD THEORY. G.Rideau.
C.R. Acad. Sci. (Paris), Vol. 247, No. 15, 1098-101 (Oct. 13, 1958). In French.

A definition of S-matrix elements is given, using only creation and annihilation operators for physical (as opposed to "bare") particles. J.C.Taylor

530.145

50. TWO-NUCLEON POTENTIAL FROM CHEW–LOW THEORY. R.T.Sharp.
Nuovo Cimento, Vol. 9, No. 1, 23-36 (July 1, 1958).

The two-nucleon potential is derived within the framework of the static cut-off pion theory of Chew and Low. Except for approximations implicit in the original Hamiltonian, the one-meson-exchange potential is exact and agrees, for example, with that of Brueckner and Watson. In the two-meson-exchange potential scattering effects are treated by the one-meson approximation of Chew and Low. The result is expressed in terms of integrals over the solution of the Low equation. The procedure is indicated for applying the method to certain non-adiabatic effects in the two-nucleon potential, to the Λ-nucleon potential, and to the three-nucleon force.

530.145

51. REMARKS ON SOME IDENTITIES IN STATIC MESON THEORY. K.Haller.
Nuovo Cimento, Vol. 9, No. 2, 346-9 (July 16, 1958).

A criterion, for deciding when it is possible to divide an equation by an operator which has zero as one of its eigenvalues, is established. Applications are given. P.Roman

530.145

52. FEYNMAN'S FUNCTIONAL METHOD IN A SIMPLE MODEL IN FIELD THEORY. R.Cirelli and A.E.Pastor.
Nuovo Cimento, Vol. 9, No. 3, 560-3 (Aug. 1, 1958). In Italian.

This method is applied to fixed-source neutral scalar meson theory, to test its equivalence with ordinary methods. R.J.N.Phillips

530.145

53. CONVERGENCE OF THE S-MATRIX. D.R.Yennie and S.Gartenhaus.
Nuovo Cimento, Vol. 9, No. 1, 59-76 (July 1, 1958).

An investigation is made of the convergence of the field-theoretic perturbation expansion of the elements of the S-matrix. For a theory characterized by a coupling linear in the boson field, it is established that if a cut-off is introduced in momentum space, then the transition amplitude for any given process over a finite-time interval, is bounded term by term by an exponential series. The extension of the method to interactions which are not linear, is, for several cases, also included. The implications of the result for theories without a cut-off is discussed from a qualitative point of view.

530.145

54. PHENOMENOLOGICAL THEORY OF THE S-MATRIX AND T, C AND P INVARIANCE. J.Werle.
Nuovo Cimento, Vol. 9, No. 4, 569-85 (Aug. 16, 1958).

General expressions for the transition matrix are given for reactions between four particles of arbitrary spins. Restrictions imposed by T, C or P invariance requirements are expressed in terms of simple equations between some phenomenological scalar coefficients which occur in the general expression for the transition matrix. For any given type of reaction one can find in this way definite physical relations which have the advantage of being free of any special assumptions and approximations.

530.145

55. DISPERSION RELATIONS FOR FORM FACTORS. Y.Nambu.
Nuovo Cimento, Vol. 9, No. 4, 610-23 (Aug. 16, 1958).

The dispersion relations for form factors are studied in perturbation theory. In particular, the relations are proved for a realistic nucleon in the form usually assumed in literature. It is demonstrated, however, that in more general cases the mass spectrum in the dispersion relations depends on the masses of the contributing particles in a peculiar way, which is different from the simple relation hitherto believed. Such a situation arises, for example, in the case of some hyperon models and bound systems such as the deuteron. A formula concerning the final state interaction to be used in conjunction with the dispersion relations is also derived from the invariance of the theory under space-time reversal.

530.145 : 539.12

56. CONTRIBUTION TO THE THEORY OF THE MULTIPLE SCATTERING OF PARTICLES. R.Mertens.
Simon Stevin, Vol. 30, Suppl., 110 pp. (1954). In Dutch, with summary (7 pp.) in English.

The problem is treated by an approximation method in which the angular distribution function is expanded in a series of Legendre polynomials (spherical harmonic method). Existing theories are reviewed and the difficulties to which they lead discussed. Milne's problem for isotropic neutrons is considered in detail (on the basis of a method due to Yvon) and is extended to the case of the multiple scattering of particles, whose single scattering law is not isotropic, in a medium of finite thickness. It is assumed that collisions between particles and atoms are elastic, and that the velocity of particles remains constant. Throughout, the Boltzmann scattering equation is the starting point of each investigation.

530.145

57. A WAVE EQUATION FOR A PARTICLE OF MAXIMUM SPIN ONE. H.Feshbach and W.Nichols.
Ann. Phys. (New York), Vol. 4, No. 4, 448-58 (Aug., 1958).

A general, first-order, linear, relativistic wave equation for a particle of arbitrary half-integral maximum spin is presented. The structure of the general theory is described briefly, while its specialization to a particle of maximum spin one is treated at greater length. The special theory describes not only the simple scalar S, pseudoscalar P, vector V, and axial-vector A mesons, but also composite "particles" possessing S, P, V and A components differing in rest mass. The restriction to unique rest mass allows the wave function to satisfy the Klein–Gordon equation. The restriction to a positive-definite energy density eliminates all composite particles except the S–P, the S–A, and the P–V. The theory is invariant under the extended Lorentz group, charge conjugation, and Hermitian conjugation.

530.145 : 539.18

58. ON THE APPROXIMATE CALCULATION OF EIGENVALUES WITH SPECIAL REFERENCE TO THE HELIUM ATOM. B.F.Gray.
J. chem. Phys., Vol. 29, No. 2, 272-5 (Aug., 1958).

A method is developed for treating the error in the energy of a variation function as a perturbation, the variation function serving to describe the "unperturbed state". An effective potential is defined from the variation function, and comparison of this with the correct potential for the helium atom gives useful information about the behaviour of the variation functions as the electronic separation approaches zero. In the second section, iterative methods of improving a variational wave-function without increasing the number of para-

meters are discussed and the conditions under which they will be applicable are examined.

530.145

59. APPLICATION OF SCHWARZ'S INEQUALITY TO PERTURBATION THEORY. B.F.Gray.
J. chem. Phys., Vol. 29, No. 2, 276-7 (Aug., 1958).

It is shown by use of the variation theorem, that under fairly general conditions the energy given to an odd order of approximation by perturbation theory is an upper bound to the correct energy. Under less general conditions it is shown that for a positive definite perturbation the energy given by an even order approximation is a lower bound and for a negative definitive perturbation it is again an upper bound. Some applications are discussed.

530.145

60. ON CONVERGENCE TO THE MØLLER WAVE OPERATORS. M.N.Hack.
Nuovo Cimento, Vol. 9, No. 4, 731-3 (Aug. 16, 1958).

It is shown that the results proved by Cook for potentials that are quadratically integrable over all space (J.M.Cook, J. Math. and Phys., Vol. 36, 82, 1957) remain valid for potentials which, for large r, fall off faster than $1/r$, and are quadratically integrable only in the finite domain. W.A.Hepner

530.145

61. SOLUTION OF SCHRÖDINGER EQUATION FOR A PARTICLE BOUND TO MORE THAN ONE SPHERICAL POTENTIAL. L.Eyges.
Phys. Rev., Vol. 111, No. 3, 683-9 (Aug. 1, 1958).

Considers the quantum-mechanical problem of a particle bound to a configuration of spherical potentials, each of finite range. If the Schrödinger equation can be solved for each potential by itself, then it is shown how to solve it for the configuration, provided the potentials do not overlap. The energy levels are the zeros of a determinant of formally infinite order, but in practice this is always well approximated by a finite determinant and often by one of small order. As illustrative examples we consider some states of a particle bound to three square wells with the configuration of an equilateral triangle, and to two truncated Coulomb potentials. The possibility of extending an approximate version of the method to overlapping potentials is pointed out.

530.145

62. CLUSTER DEVELOPMENTS FOR JASTROW WAVE FUNCTIONS. I. GENERAL CLUSTER DEVELOPMENT OF THE DISTRIBUTION FUNCTIONS. C.D.Hartogh and H.A.Tolhoek.
Physica, Vol. 24, No. 9, 721-41 (Sept., 1958).

This paper is concerned with a form of wave-function, which was proposed by Jastrow for the ground state of a fermion gas with short-range interactions. The influence of the introduction of forces is represented by a correlation factor F, which is a function of the particle coordinates and which may contain variational parameters, in front of the Slater determinant for the unperturbed ground-state wave-function. This wave-function may be used as a trial function in a variational principle. The evaluation of the energy can make use of cluster-like expansions for the k-particle distribution function $g_k(r^k)$, which are given in this paper in a general form for fermions without spin. The expansion of $g_k(r^k)$ can be made for the limit of large total volume and reads

$$g_k(r^k) = n^k \sum_{l=k}^{\infty} b_{k,l}(r^k),$$

where the $b_{k,l}(r^k)$'s are cluster integrals which depend on the density, n, only, and not on the total number of particles. It seems plausible that this expansion converges rapidly, if $n\delta^3 \ll 1$ (δ range of correlations in the F-factor).

530.145 : 517.5

EXPLICIT EXPRESSION FOR SPHERICAL HARMONICS.
See Abstr. 2

530.145 : 517.9

SOLUTIONS OF THE DIFFERENTIAL EQUATIONS $(\Box \mp \kappa^2)\psi(r,t) = \delta^4(r,t)$. See Abstr. 5

STATISTICAL MECHANICS. TRANSFER PROCESSES

530.16

63. ON THE THEORY OF RELAXATION. I. THE THERMODYNAMIC FOUNDATIONS AND THEIR MATHEMATICAL SOLUTION. S.Kästner.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 6-8, 377-99 (1958). In German.

The fundamental thermodynamic equations of relaxation are established in complete generality for homogeneous systems near thermodynamic equilibrium. Beside the phenomena of pure relaxation (diffusion, conduction, etc.) those of internal friction (e.g. viscosity or ohmic resistance) are also considered. The theory is presented in tensor form in the space of the variables of state, and this representation is useful for the solution of the equations. The results are summarized in tabular form, and are applied to mechanical and dielectric relaxation. F.Ansbacher

530.16

64. NEW VARIATIONAL PRINCIPLE FOR TRANSPORT THEORY. J.Devooght.
Phys. Rev., Vol. 111, No. 3, 665-7 (Aug. 1, 1958).

A general variational principle of Kahan, Rideau, and Rousso-poulos is shown to be applicable to problems of transport theory and in particular to the solution of the Milne problem. The variational principle yields directly the flux at every point, not only at infinity, unlike the classical methods for asymptotic densities.

530.161

65. ON THE DERIVATION OF RATE EQUATIONS. R.Ingraham.
Nuovo Cimento, Vol. 9, No. 1, 99-124 (July 1, 1958).

Reasons are given for doubting that irreversible behaviour can be derived from mechanics without the various traditional averaging processes. A critical study of the Van Hove–Brout–Prigogine long time-weak coupling theory which dispenses with these averages is made. The two main objections are (1) mathematical inconsistencies in the quantum-mechanical formulation of the "diagonal singularity" of the mixing perturbation, supposedly responsible for the irreversibility, and (2) a physically inadmissible prescription for treating poles in improper energy integrals. Particular consequences are (1) an ambiguous prescription for evaluating the long time-weak coupling limit of improper integrals and (2) violation of the unitarity of the transition operator, respectively. Diagonal singularity in the "continuum limit" is reformulated. The limit transition operator is explicitly evaluated and exhibits only reversible behaviour.

530.162

66. THE PERSISTENCE OF THERMODYNAMIC EQUILIBRIUM IN AN ISOLATED MATERIAL SYSTEM. J.Seiden.
C.R. Acad. Sci. (Paris), Vol. 247, No. 1, 38-40 (July 7, 1958).
In French.

It is shown that by adopting a more physical definition of thermodynamic equilibrium than that of Boltzmann, the persistence of equilibrium for a macroscopic system follows from the classical dynamical laws without further assumptions. The macroscopic equilibrium state is defined for all points of phase space for which the deviation of various macroscopic physical quantities from their most probable values is a very small but finite number (dependent on the macroscopic quantity). F.Ansbacher

530.162

67. STATISTICAL-KINETIC THEORY OF PHASE CHANGE. L.Gold.
J. chem. Phys., Vol. 29, No. 1, 51-5 (July, 1958).

Reaction rate kinetics is applied to the phenomenon of phase change. Two rate constants, one for nucleation and the other for growth processes, are embodied in the theory. These microscopic parameters are of a basic nature, with a significance quite distinct from the macroscopic quantities employed by Johnson, Mehl, and Avrami (J.M.A.) in the conventional phenomenological formulation. Expressions for the nucleation rate and the degree of transformation are established once the basic properties of the Poisson exponential binomial limit distribution have been determined. The statistical kinetic theory does indeed lead to a sigmoid-shaped transformation curve commonly observed in phase changes. An essential ingredient of the theory, not incorporated in the J.M.A. phenomenological theory, is the role of nuclei and specimen size; unusual behaviour may be expected in small particles undergoing transformation.

530.162

68. BROWNIAN MOTION OF A PARTICLE IN A LINEAR CHAIN. P.C.Hemmer and H.Wergeland.
K. Norske Vidensk. Selsk. Forhandl., Vol. 30, No. 22, 137-43 (1957).

The integrals of motion are obtained as functions of time and initial conditions. Probability is introduced through indeterminacy of initial conditions. The statistical and dynamical elements are clearly distinguishable, at least in this particular case, both for the classical and quantum description. F.Ansbacher

530.162

69. ON THE BEHAVIOUR OF THE DISTRIBUTION FUNCTION OF A MANY-PARTICLE SYSTEM NEAR THE FERMI SURFACE. D.A.Kirzhnits.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1625-8 (1958). In Russian.

The form of the distribution function of a system of electrons near the Fermi surface is investigated in the Hartree approximation for a weak inhomogeneous distribution. It is shown that in this region the role of inhomogeneities becomes very significant and consequently the correct expression for the distribution function presented in the paper greatly differs in this region from the expression usually applied (computed on basis of the Thomas—Fermi model). It is noted that the latter is totally invalid in those problems in which the vicinity of the Fermi boundary plays an important role.

530.19 : 539.12

70. MILNE'S PROBLEM IN THE CASE OF ANISOTROPIC SCATTERING. (APPLICATION TO THERMAL NEUTRONS). D.Lyons.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 6-8, 400-23 (1958). In German.

A generalization of Milne's integral equation is established for anisotropic scattering, and it is shown that solutions of reasonable accuracy may be derived by an elementary procedure. Results involve the parameter $x = 15\cos^2\Theta$, $3 \leq x \leq 9$, and numerical calculations are made for integral values of x. The isotropic case x = 5 appears as a singular case, for which results may be derived by extrapolation. R.A.Newing

GENERAL MECHANICS. MECHANICS OF SOLIDS

531.231

71. MOMENTS OF INERTIA OF PLANE TRIANGLES. J.Satterly.
Amer. J. Phys., Vol. 26, No. 7, 452-3 (Oct., 1958).

The moments of inertia of the triangle are calculated about various axes by direct geometrical methods and confirmed by experiment.

531.31

72. GRAPHIC AIDS FOR TEACHING CORIOLIS FORCE. M.J.Walker.
Amer. J. Phys., Vol. 26, No. 6, 392-5 (Sept., 1958).

Graphical "paper experiments" are described which facilitate the study of Coriolis force and other forces which arise from the use of accelerated axes of reference. The development emphasizes the operational definition that an inertial frame of reference is a coordinate system in which a free body moves at constant velocity in a straight line. It is pointed out that the tangential component of Coriolis force is just that force needed to produce the torque which conserves angular momentum.

531.355 : 525.3

73. ELLIPTIC ORBITS IN A FRICTIONAL ATMOSPHERE. D.G.Parkyn.
Amer. J. Phys., Vol. 26, No. 7, 436-40 (Oct., 1958).

An "atmosphere" is postulated, which is in agreement with the data available, and the consequences for elliptic orbits are investigated. The analysis developed is general but the numerical results deduced are of course dependent upon the available data, with the consequent possibility of error. The problem of the life span of a satellite is solved, the numerical values taken being those for Sputnik I.

531.383

74. ON THE TENACITY OF A MECHANICAL SYSTEM IN MOTION. G.Gotusso.
R.C.Accad. Naz. Lincei, Vol. 24, No. 6, 693-700 (June, 1958). In Italian.

A mechanical system, described in terms of the generalized coordinates q_r, is in the state of motion $\dot{q}_r = K\delta_{1r}$, where K is large. It is shown that the forces required to produce a finite change in the motion are at least of order K. A particular example is the tendency of the axis of a gyroscope to preserve its direction. R.A.Newing

531.51 : 530.12

75. GRAVITATIONAL INSTABILITY OF AN INFINITE HOMOGENEOUS AND STATIONARY TURBULENT MEDIUM. P.C.Jain.
Proc. Nat. Inst. Sci. India A, Vol. 24, No. 3, 230-3 (1958).

By considering an infinite turbulent medium to be homogeneous in space and stationary in time, Jeans' criterion of stability is discussed. Using the equations of motion and of continuity for a compressible fluid, the equation in density fluctuations is deduced. Then, on the basis of the assumptions that the fourth-order correlation is related to the second-order correlations in the same manner as in a joint-Gaussian distribution, and that the variations in density and pressure are adiabatic, the condition for gravitationally unstable turbulent medium is derived, which differs from Jeans' condition.

531.57

76. USE OF CAPACITOR DISCHARGES TO PRODUCE HIGH-VELOCITY PELLETS. D.E.Bloxsom, Jr.
J. appl. Phys., Vol. 29, No. 7, 1049-51 (July, 1958).

There is a limit to pellet velocities obtainable from guns using chemical processes. In order to remove this limit, high pellet accelerating pressure was obtained by heating helium to high temperatures by means of electrical discharges. Helium was heated to 53 000 lb/in.^{2} and 6350°K. This helium was used to accelerate nylon pellets of $\frac{1}{8}$ in. diameter to 9800 ft/sec. Expected nylon pellet velocity of 23 500 ft/sec, from 36% energy transfer efficiency from condensers to helium, was not obtained due to forced convection heat transfer in the gun barrel.

531.57

77. VAPORIZATION OF PROJECTILES ON IMPACT. G.Larikov.
Nature (London), Vol. 182, 468 (Aug. 16, 1958).

Zinc vapour was found to have condensed from a brass liner fired into a steel block with transverse apertures, showing vaporization had taken place. Contrary to some theories, the slug formed when a copper cone was fitted into a steel liner contained a copper core, and had not been turned inside out. P.Gray

531.66

78. EXPERIMENT FOR MEASURING THE COEFFICIENT OF RESTITUTION. F.W.Van Name, Jr.
Amer. J. Phys., Vol. 26, No. 6, 386-8 (Sept., 1958).

The coefficient of restitution is determined from measurements on the oblique impact between two spheres. A typical set of data is presented.

MECHANICAL MEASUREMENTS

531.717.1 : 548.732

79. FILM THICKNESS DETERMINATION FROM SUBSTRATE X-RAY REFLECTIONS. D.T.Keating and O.F.Kammerer.
Rec. sci. Instrum., Vol. 29, No. 1, 34-6 (Jan., 1958).

A method is given for the determination of the thickness of films using X-rays diffracted from the substrate. The X-rays pass through the film and are diffracted by the substrate back to the counter, the intensity being reduced by absorption due to the double transmission through the film. No assumptions need be made about the substrate reflection. Unknown conditions of the substrate are eliminated by measurement of the intensity of two orders of a reflection, or measurement of the intensity of a reflection using two different incident radiations. The method is suitable for all types of film, and is particularly useful in measurements of films containing elements of the substrate for which cases X-ray fluorescence techniques are of little value. The procedure is illustrated with a measurement of the thickness of zirconium nitride on a zirconium substrate.

MECHANICS OF FLUIDS

532.13

80. STUDIES OF THE VISCOSITY AND SEDIMENTATION OF SUSPENSIONS. IV. CAPILLARY-TUBE VISCOMETRY APPLIED TO STABLE SUSPENSIONS OF SPHERICAL PARTICLES. G.H.Higginbotham, D.R.Oliver and S.G.Ward.
Brit. J. appl. Phys., Vol. 9, No. 9, 372-7 (Sept., 1958).

For Pt III, see Abstr. 3479 (1955). A description is given of a series of measurements of the viscosity of stable suspensions of spherical particles in an efflux-type capillary-tube viscometer. It is shown that a form of wall-effect is present in the tube, which

causes the apparent viscosity of the suspensions to decrease with decreasing tube-size. The suspensions are shown to behave as though a layer of pure liquid were present along the tube walls, though the layer appears to be only hypothetical in nature. The values of the wall-layer thickness obtained in the present work are used in a brief assessment of a recently-proposed "concentration" theory of wall effect (Abstr. 3519/1956). The final values of the relative viscosity, corrected for wall effect, show no dependence on absolute particle size or particle size-range. All series of results are shown to be governed by a single type of equation, which reduces to that of Einstein at very low values of the volume concentration.

532.13 : 532.14

81. THE VISCOSITY AND DENSITY OF BENZENE NEAR ITS FREEZING POINT. P.M.Hu and R.W.Parsons.
Proc. Phys. Soc., Vol. 72, Pt 3, 454-7 (Sept., 1958).

There is no discontinuity in the viscosity—temperature curve of benzene at its freezing point. The simple exponential relationship is only an approximation. The temperature dependence of the exponential factor might indicate a temperature dependence of the average intermolecular separation, as benzene has a large coefficient of expansion. R.Schnurmann

532.13.08

82. ACCURATE MEASUREMENT OF THE VISCOSITY OF LIQUIDS. E.W.J.Mardles.
Nature (London), Vol. 182, 438-9 (Aug. 16, 1958).

Report of a conference in London on 6 June 1958, which was organized jointly by the Institute of Petroleum and the British Society of Rheology. Six papers were presented and discussed. These dealt with: the limitations to the accuracy obtainable with the capillary tube method and the relative potential advantages of the oscillating vessel and logarithmic decrement methods; a means of producing well-defined high rates of shear without the accompaniment of appreciable heating of the liquid; and — by way of a specialized survey — the precise measurement of kinematic viscosity in the petroleum industry. R.Schnurmann

532.133 : 532.584

83. ELECTROVISCOUS EFFECT. VARIATION OF VISCOSITY WITH PARTICLE CHARGE. J.B.Donnet and C.Reitzer.
C.R. Acad. Sci. (Paris), Vol. 247, No. 13, 929-32 (Sept. 29, 1958). In French.

Observations of the viscosity of aqueous suspensions of carbon black are recorded, which show the viscosity to be practically independent of the electric charge carried by the particles, provided this is sufficiently great to ensure a stable suspension. J.G.Oldroyd

532.133

84. COMPUTATION OF VISCOSITY OF VISCOSE SOLUTIONS. M.N.Marathe.
J. sci. industr. Res., Vol. 17B, No. 7, 256-9 (July, 1958).

The viscosities of viscose solutions are correlated with factors such as effective maturing time and temperature, ratio of cellulose to free alkali in alkali cellulose and the composition (cellulose and sodium hydroxide content) of viscose. It is assumed that catalytic effects are absent. The ranges for the different factors studied cover those normally met with in industrial practice. A general equation giving viscosity in terms of all the above factors is formulated, and the conditions under which the equation is applicable are stated. The relations are empirical and are not universally applicable. The equation is useful in determining the viscosity of viscose solutions under specified process conditions.

532.137

85. CAPILLARY-TUBE VISCOMETRY WITH NEGLIGIBLE KINETIC ENERGY EFFECTS. W.A.Caw and R.G.Wylie.
Nature (London), Vol. 182, 1153-4 (Oct. 25, 1958).

By forming a gradual flare, generally a few centimetres long, at each end of the capillary tube, the kinetic energy effect can be practically eliminated. The flares may be so long as to run together at the centre of the capillary, which then possesses no parallel part. A method is indicated for producing the long flare. R.Schnurmann

532.14

86. THE MEASUREMENT OF SMALL CHANGES IN DENSITY IN LARGE [SOLID] SPECIMENS. G.A.Bell.
Austral. J. appl. Sci., Vol. 9, No. 3, 236-44 (Sept., 1958).

This differential method makes use of a dummy of the same material as the specimen and of closely the same mass and volume. The measurements are made by hydrostatic weighing in a liquid of known density, and the method is particularly suited to the measurement of changes in density of large specimens and also to differences in density between specimens having closely the same mass and volume. The advantage of the method is that it does not require accurate control or measurement of temperature in order to attain a precision approaching 1 part in 10^5 of the density of the specimen.

532.5

87. THE SOLUTION OF BOUNDARY VALUE PROBLEMS FOR A GENERAL HODOGRAPH EQUATION. A.G.Mackie.
Proc. Cambridge Phil. Soc., Vol. 54, Pt 4, 538-53 (Oct., 1958).

The solution is found of certain boundary value problems appropriate to the flow of an inviscid, compressible fluid past a wedge-shaped profile. The most general hodograph equation in the form

$$\frac{\partial^2\Psi}{\partial\sigma^2} + k(\sigma)\ \frac{\partial^2\Psi}{\partial\theta^2} = 0$$

is used. Expressions are found for the position coordinates and the drag. The resulting solutions are then discussed for functions $k(\sigma)$ appropriate to Chaplygin's equation, Tricomi's equation and the equation of Tomotika and Tamada. The case of Helmholtz flow past a wedge with sonic velocity upstream is treated in detail, and the resulting expressions for the drag enable an estimate to be made of the error which results in using approximations to Chaplygin's equation.

532.51 : 541.124

88. ON CHEMICAL SURFACE REACTIONS IN HYDRODYNAMIC FLOWS. P.L.Chambré.
Appl. sci. Res. A, Vol. 6, No. 2-3, 97-113 (1956).

The formulation of flow problems involving chemical reactions on solid surfaces. The analysis allows one to trace a reaction history of arbitrary complexity in a general class of boundary-layer type flow-fields which cover both external and internal flows under isothermal and non-isothermal conditions.

532.513.1

89. THE FORCES EXPERIENCED BY TWO ELLIPTIC CYLINDERS IN A UNIFORM FLOW AT SMALL REYNOLDS NUMBERS. S.Kuwabara.
J. Phys. Soc. Japan, Vol. 13, No. 5, 506-19 (May, 1958).

Using Imai's general method of solving Oseen's two-dimensional equations, the drag and lift coefficients for one of the two cylinders are calculated. When the thickness ratios of both elliptic cylinders are taken to be unity, the general expressions for these coefficients reduce to those for the case of two circular cylinders, which was obtained in a previous paper (Abstr. 5678/1958). The expressions for the case of two flat plates are also included as a special case.

532.517

90. ON THE HYDRODYNAMICS OF VISCO-ELASTIC FLUIDS. L.J.F.Broer.
Appl. sci. Res. A, Vol. 6, No. 2-3, 226-36 (1956).

The hydrodynamical equations of motion for a visco-elastic fluid are established. The exact solution for periodic laminar flow in a cylindrical tube and an approximate solution for flow in a film of variable thickness are given. The importance of the elasticity number $N = \tau\nu/R^2$, determining the ratio of elastic to inertia forces, is pointed out.

532.517.2

91. DISSIPATION OF ENERGY DUE TO SOLID PARTICLES SUSPENDED IN A VISCOUS LIQUID. H.Brenner.
Phys. of Fluids, Vol. 1, No. 4, 338-46 (July-Aug., 1958).

A general method is developed for calculating the additional mechanical energy dissipation incurred by the pressure of solid particles suspended in an incompressible viscous fluid in laminar flow. The development is applicable to flow in any apparatus within which the steady motion of a homogeneous fluid can be described by omitting the inertial terms in the Navier—Stokes' equations or in which the motion occurs in concentric circles. The validity of the results obtained is limited to situations in which the particle dimensions are small compared to those of the apparatus in which the motion is occurring. The technique, based largely upon a reciprocal theorem for the inertialess flow of viscous fluids, is employed to calculate the permanent pressure drop accompanying the passage of liquid through a bed of fluidized solids. When the particles are uniformly distributed throughout the bed, this pressure diminution is equal to the bed weight (corrected for buoyancy) per unit area of duct — in agreement with experimental data on systems in a state of particulate fluidization. Calculations are also presented for the

permanent pressure arising from the passage of fluid past an immobilized spherical particle within a cylindrical duct. Einstein's formula for the apparent viscosity of a dilute suspension of spherical particles is also deduced. By means of a new definition of suspension viscosity the heretofore different points of view advanced by Einstein, Jeffery, and Burgers are seen to be consistent with one another. Einstein's result if shown to be independent of the type of viscometer employed provided that the motion of a homogeneous fluid within the device fulfills the previous criteria. In the case of non-spherical particles it is demonstrated that the constant in Einstein's viscosity equation (which has a value of 2.5 for spheres) can never be less than unity, whatever the shape of the rigid particles or their orientation with respect to the axes of the apparatus.

532.517.3

92. ON THE EQUATION OF MOTION FOR A PARTICLE IN TURBULENT FLUID. S.Corrsin and J.Lumley.
Appl. sci. Res. A, Vol. 6, No. 2-3, 114-16 (1956).

An improvement on Tchen's generalization of the Oseen theory of motion of a sphere in a viscous liquid is suggested, in the case when the flow is not steady (and may be turbulent if the sphere is sufficiently small). J.G.Oldroyd

532.517.3

93. THE TRANSITION PROCESS AND OTHER PHENOMENA IN VISCOUS FLOW. E.R.Lindgren.
Ark. Fys., Vol. 12, Paper 1, 1-169 (1957).

A critical survey of currently accepted concepts relating to the transition from laminar to turbulent flow in pipes. Experiments are reported demonstrating the frequency and decay of turbulent flashes in distilled water and in birefringent bentonite sols, especially in relation to the roughness of the pipe wall. Continuous observations of pressure and of local disturbance by means of a streaming birefringence technique were made at two stations simultaneously. References. J.G.Oldroyd

532.517.4

94. ON THE TRANSFER OF ENERGY IN BURGERS' MODEL OF TURBULENCE. W.H.Reid.
Appl. sci. Res. A, Vol. 6, No. 2-3, 85-91 (1956).

The distribution of energy transfer is examined for two given energy spectra: one corresponding to an exponential correlation function, and the other to a block spectrum. Due to the absence of a pressure term, it is found that Burgers' equation (Proceedings of the Seventh International Congress of Theoretical and Applied Mechanics, Istanbul, August 1952) does not lead to an algebraic behaviour of the correlation functions for large separations. It is also found that, in general, energy is transferred not only forward to higher wave-numbers but also backwards to smaller wave-numbers and, hence, that the usual cascade picture, in which energy flows in one direction only, may not be an exact one.

532.525

95. EXPERIMENTS IN LIQUID ATOMIZATION BY AIR STREAMS. H.F.Hrubecky.
J. appl. Phys., Vol. 29, No. 3, 572-8 (March, 1958).

Water is atomized by a high-velocity air stream using various methods of injection and water nozzle positions. Low water volume rates and velocities, air velocities up to acoustic, and ratios of air volume to water volume rates up to 25000 were utilized. Results indicate water injection into region of maximum velocity, parallel to the air flow gives highest degree of atomization under similar conditions. Comparison is made with the Tanasawa—Nukiyama correlation and discrepancies in droplet sizes at high air velocities are found and discussed.

532.542.1

96. ON THE NONLINEARITIES OF FLUID FLOW IN NON-RIGID TUBES. J.W.Lambert.
J. Franklin Inst., Vol. 266, No. 2, 83-102 (Aug., 1958).

Several discrepancies between linear theory and experimental results are explained by the non-linear theory. Two simultaneous non-linear differential equations are considered for the non-steady one-dimensional motion of an ideal fluid in a rotationally symmetric tube. To these must be added an equation of state of the tube expressing the tube radius as a function of the pressure difference. The general solution of these equations for a linearly elastic tube is expressed in an analytic form convenient for computation on a digital computer. A graphic method of solution is also presented and applied to the problem of a large pulse wave in a semi-infinite tube. Data for the problem presented are intended to simulate the problem of a heart pulse wave in the aorta. Exact stress—strain data for the aorta and approximate heart pulse data are used. The effect of the non-linearities included is found to be significant.

532.584

97. A CONTRIBUTION TO THE PROBLEM OF CONCENTRATED SUSPENSIONS. D.Ryšavý.
Z. phys. Chem. (Leipzig), Vol. 208, No. 5-6, 293-308 (April, 1958). In German.

The flow properties of concentrated suspensions of polyvinylchloride in a plasticizer were found to be almost identical whether the diameter of the latex particles was 16 μ or 45 μ, whereas treatment of the particles in a hot air spray dryer changed their rheological behaviour. The author concludes that the "character" of the surface of the particles governs the flow behaviour of the suspensions. R.Schnurmann

532.59

98. GROWTH OF SMALL WATER WAVES WITH WIND SPEED AND FETCH. B.L.Hicks and E.A.Huber.
Phys. of Fluids, Vol. 1, No. 5, 454-5 (Sept.-Oct., 1958).

There is little quantitative knowledge of the characteristics of small wind waves; a brief account is given of measurements of the mean square surface displacement of water in a small lake for different combinations of wave frequency, mean wind speed and fetch. Graphical analysis shows that the energy spectrum is flat on the low frequency side and falls off as $(\text{frequency})^{-5}$ on the high frequency side. This variation of the spectrum is in general agreement with theory, but further data is needed to show the relative importance of resonance and shear mechanisms in the formation of wind waves. P.G.Morgan

532.596

99. GRAPHICAL METHOD OF CALCULATING THE PROPAGATION OF SURGES IN A CHANNEL OF ARBITRARY SECTION. J.Nougaro and P.Duffour.
C.R. Acad. Sci. (Paris), Vol. 247, No. 12, 860-1 (Sept. 22, 1958). In French.

A graphical method, based on Bergeron's classical method and hitherto used to study motion of a tidal wave along a channel of rectangular section (C.R. Acad. Sci., Paris, Vol. 240, No. 17, 1689, 1955), is extended as an approximate method when the section is trapezoidal. J.G.Oldroyd

532.6

100. ON A NEW THEORY OF CAPILLARITY. A.Sentis.
C.R. Acad. Sci. (Paris), Vol. 247, No. 13, 913-15 (Sept. 29, 1958). In French.

An observed variation of effective surface tension with radius, when a ring is lifted up out of a liquid surface, is explained in terms of a new theory of surface phenomena based on the hypothesis that a liquid is characterized by a finite time of response. J.G.Oldroyd

532.64

101. THE WATER WETTABILITY OF METAL SURFACES. D.J.Trevoy and H.Johnson, Jr.
J. phys. Chem., Vol. 62, No. 7, 833-7 (July, 1958).

Low contact angles with water may be obtained on the surfaces of chemically reactive metals by a process involving chemical cleaning with powerful oxidizing acids, followed by electropolishing to restore smoothness to the etched specimens. By using highly refined handling techniques, contact angles in the range 0-11°, were obtained on aluminium, brass, copper, magnesium, nickel, stainless steel and zinc. The low contact angles are considered a good indication that organic contamination was virtually absent from the electropolished surfaces. The possibility of spurious inorganic contamination, apart from the normal oxide film, also was considered, and, in the case of copper electropolished in phosphoric acid, the residual phosphate on the surface was estimated by coulmetric reduction and shown to be much less than a monolayer. The preparatory technique used in this study is applicable to a wide variety of metals and alloys and serves to demonstrate experimentally the inherent water wettability of clean metal surfaces. It also provides a means of preparing clean, smooth substrates on which fatty acids or other compounds may be deposited and their behaviour observed in determining wettability and adhesion. Mechanical polishing, followed be exhaustive rinsing with hot or cold redistilled organic solvents, was not effective in producing low contact angles on metal surfaces.

MOLECULAR THEORY OF LIQUIDS

532.7 : 534.23

102. SOUND ABSORPTION IN RELATION TO FREE VOLUME OF LIQUIDS. H.Singh.
Nuovo Cimento, Vol. 9, No. 3, 545-6 (Aug. 1, 1958).

Using previous measurements, the absorption function at various

pressures and temperatures has been calculated for methyl, ethyl, n-propyl and n-butyl alcohols. It is shown that the relative volumes, at different temperatures and pressures, corresponding to a fixed absorption value for each alcohol, remain essentially constant.

B.J.Wilson

532.71

103. TRANSPORT PROCESSES IN IONIC MEMBRANES. K.S.Spiegler.
Trans Faraday Soc., Vol. 54, Pt 9, 1408-28 (Sept., 1958).

A simple molecular model representing a solid ionic medium in equilibrium with a salt solution is described. Solid ionic media are permeable ion-exchanging bodies, e.g. ion-exchange columns, soil aggregates, certain shales, and ion-exchange membranes. The theory is particularly adapted to the latter. The transport processes caused by pressure, electrical and osmotic forces are described in terms of the volume concentrations of ions, water, and solid, and certain "friction coefficients" between these components. This analysis suggests approximations which reduce the number of the experiments needed for describing the transport processes. Application of the theory leads to relations of transport phenomena in a series of membranes of similar chemical nature, but different capacity and water content. This is illustrated by two sets of numerical examples where the theory is applied to data of other authors for cross-linked polymethacrylate and sulphonated polystyrene membranes respectively. The model leads to flux equations which are consistent with the postulates of steady-state thermodynamics. In addition to the known laws of electrokinetics, permeability and electrical conductance, the theory also leads to a number of hitherto untested relationships.

532.72 : 530.16

104. THE RANDOM-WALK MODEL WITH AUTOCORRELATION OF FLOW THROUGH POROUS MEDIA. A.E.Scheidegger.
Canad. J. Phys., Vol. 36, No. 6, 649-58 (June, 1958).

An investigation is reported of the implications of a random-walk model as opposed to random residence-time models. Although the random-walk model is physically not as satisfactory as other statistical models, it has the advantage of enabling one to introduce and to investigate easily the effect of autocorrelation between subsequent time steps. It is shown that, if autocorrelation exists, the mixing process in porous media is governed by a telegraph equation rather than by a diffusivity equation. Expressions for the constants occurring in the telegraph equation are deduced in terms of other dynamical variables.

532.72 : 533.15

105. THEORY OF DIFFUSION NEAR WALLS. M.Fixman.
J. chem. Phys., Vol. 29, No. 3, 540-5 (Sept., 1958).

A model previously proposed for momentum transport in fluids, in which momentum and energy are carried by dipole density waves centred on the molecule of interest, is applied to a calculation of the hindering effect of a wall on diffusion. Consideration is given to both specular and diffuse reflection of the density waves by the wall. The ratio γ of the diffusion constant at a distance l from the wall to the bulk fluid diffusion constant is calculated for diffusion parallel to the wall (γ_X), and perpendicular to the wall (γ_Z). For the diffuse reflection case $\gamma_X = (l_0 + l_0^2/8l^2)/N$; $\gamma_Z = 1/N$, $N = 1 + (l_0^2/4l^2) + (3l_0^4/288l^4)$, and l_0 is estimated as $9\eta(m_0/kT)^{\frac{1}{2}}/2\nu$, where η is the shear viscosity, m_0 the molecular mass, and ν the mass density of solvent; l_0 may be as large as several hundred angstroms for simple liquids at room temperature.

532.72

106. SOME EXAMPLES OF TURBULENT DIFFUSION IN LIQUID METALS. A.Paoletti and M.Vicentini.
Phys. of Fluids, Vol. 1, No. 5, 453-4 (Sept.-Oct., 1958).

In the measurement of the self-diffusion coefficient in liquid metals, the concentration may be expressed as a function of distance, in terms of the self-diffusion coefficient and the time in which the diffusion takes place. Experimental results confirm this, but values of the self-diffusion coefficient are erratic. The standard deviation for turbulence diffusion is proportional to the dispersion, provided that the time length of diffusion is much greater than the characteristic time scale of turbulent motion; abnormal and non-symmetrical penetration curves are obtained when this condition does not hold.

P.G.Morgan

532.77

107. A STUDY OF THE ELECTRON PARAMAGNETIC RESONANCE OF LITHIUM IN SOLUTION IN LIQUID AMMONIA. A.Charru.
C.R. Acad. Sci. (Paris), Vol. 247, No. 2, 195-7 (July 16, 1958). In French.

The line shape of the electron paramagnetic resonance of fairly concentrated solutions (~ 0.1 mol/litre) of lithium in liquid ammonia was studied as a function of concentration, time after manufacture, and temperature.

J.M.Baker

532.77

108. SOLUBILITY OF HELIUM AND NEON IN LIQUID ARGON. AN APPROXIMATION TO THE ENTROPY OF LATTICE VACANCY FORMATION IN LIQUID ARGON. F.E.Karasz and G.D.Halsey, Jr.
J. chem. Phys., Vol. 29, No. 1, 173-9 (July, 1958).

The solubilities of helium and neon in liquid argon were measured over the temperature range 83.9 to 87.5°K. The observed heat of solution for helium is 1520 cal/mole and for neon is 390 cal/mole. These data are analysed by means of a modified Lennard-Jones–Devonshire treatment to yield an entropy for lattice vacancy formation of approximately 24 eu.

532.77

109. NUCLEAR MAGNETIC RELAXATION IN MIXTURES OF LIQUIDS. L.Giulotto, G.Lanzi and L.Tosca.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1213 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

532.78 : 536.48

110. RADIAL ATOMIC DISTRIBUTION IN LIQUID HELIUM-4 BY X-RAY SCATTERING. W.L.Gordon, C.H.Shaw and J.G.Daunt.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 117-28 (1958).

Measurements were made of the scattering of CuKα X-rays ($\lambda = 1.54$ A) from liquid helium at several temperatures between 1.4 and 4.2°K, and from gaseous helium at 4.2°K in the same apparatus. The measurements were made with a low-background proportional counter over a range of scattering angles from 1.5° to 90° at 1.4 and 4.2°K, and for lesser angular ranges at other temperatures. The gas scattering gives a new comparison with theory for the total differential scattering cross-section of the helium atom. The liquid structure factor is found to be unity within the experimental error in the angular range from 65° to 90°, and it seems reasonable to assume that it remains unity for larger angles. On this assumption the radial atomic distribution for the liquid is computed by using the standard Fourier inversion procedure. Estimates are made of the mean separation of nearest neighbours in the liquid, as well as the coordination number at the various temperatures.

MECHANICS OF GASES. VACUUM TECHNIQUE

533.2

111. COMPRESSIBILITY ISOTHERMS OF ARGON AT TEMPERATURES BETWEEN –25°C AND –155°C, AND AT DENSITIES UP TO 640 AMAGAT (PRESSURES UP TO 1050 ATMOSPHERES). A.Michels, J.M.Levelt and W.de Graaff.
Physica, Vol. 24, No. 8, 659-71 (Aug., 1958).

The results are corrected for gravitational effects. The position of the coexistence boundary line and of the critical point is derived. The experimental second virial coefficients are compared with the theoretical values of the Lennard-Jones 6-12 potential.

533.21 : 539.19

112. COMPRESSIBILITY AND INTERMOLECULAR FORCES IN GASES: METHANE.
H.W.Schamp, Jr, E.A.Mason, A.C.B.Richardson and A.Altman.
Phys. of Fluids, Vol. 1, No. 4, 329-37 (July-Aug., 1958).

The compressibility of a sample of very pure methane was measured with high precision from 0° to 150°C and over a pressure range of about 20 to 230 atm. The precision attained is of the order of 1 part in 10^4. Small but consistent discrepancies exist between the present results and earlier measurements, and it is believed these discrepancies are the result of a small impurity of ethane in the methane used earlier. The virial coefficients of methane are redetermined from the present measurements, and the intermolecular forces of methane are calculated from the second virial coefficient for several forms of force laws. These force laws are then used to calculate the third virial coefficient, the crystal properties at 0°K, and the viscosity for comparison with experiment. All the force laws fit the second virial coefficient very well, but some can be eliminated on the basis of the other properties.

533.27

113. SEPARATION OF GAS MIXTURES IN A CIRCULAR STREAM. H.G.Nöller and H.J.Mürtz.
Naturwissenschaften, Vol. 45, No. 16, 382-3 (1958). In German.

In preliminary experiments a separation of H_2–CO_2 and of

A^{36}–A^{40} was obtained when a jet of either of these gas mixtures was shot tangentially into a cylindrical evacuated vessel. The theoretical separation factor for the centrifugal forces acting on the molecules was not attained owing to friction forces.

R.Schnurmann

533.5 : 539.1.07

114. VACUUM TECHNIQUES IN THE ATOMIC ENERGY INDUSTRY. H.Kronberger.
Proc. Instn Mech. Engrs, Vol. 172, No. 3, 113-32 (1958).

Basic design rules are given and illustrated by examples of flanges, valves, and other components. Vacuum testing methods are discussed. The charcoal–Pirani technique of testing is favoured for most applications (tests can be carried out on components before they are degassed and "clean"; equipment and operation are simple). The management of vacuum work is discussed and a method of quality control by means of binomial distribution charts is described which has been useful in improving systematically the vacuum tightness of manufactured components.

533.59 : 539.18

115. CLEANUP OF ATOMIC HYDROGEN. K.B.Blodgett.
J. chem. Phys., Vol. 29, No. 1, 39-43 (July, 1958).

When hydrogen is dissociated by an incandescent tungsten filament in a glass tube, some of it is cleaned up if the tube is cooled in liquid air. The amount cleaned up can be greatly increased by coating the inner wall with mercury or copper. In one experiment the amount cleaned up in cold mercury was equivalent to 14 monolayers of atomic hydrogen. The cleanup proceeded at a diminishing rate until the pressure fell to the value at which hydrogen left the mercury as fast as it entered. When hydrogen was cleaned up in a very thin coating of mercury there were 1.5 to 1.8 atoms of mercury per atom of hydrogen. All the cleaned-up gas was recovered when the tube was brought to room temperature. After cleanup in copper there was little recovery until the temperature rose above -150^{0}K.

533.59 : 539.1.07

116. EASILY MOUNTED ALUMINUM OXIDE FOILS FOR WINDOWS AND BACKINGS. U.Hauser and W.Kerler.
Rev. sci. Instrum., Vol. 29, No. 5, 380-2 (May, 1958).

The well-known difficulties with preparation, handling, and mounting of thin foils are avoided by the use of aluminium oxide foils (25 to 250 $\mu g/cm^2$, or 700 to 7000 A thickness) which are grown on a solid piece of mechanically shaped aluminium that serves also as the necessary robust frame. These foils have excellent properties for an application in the spectroscopy of particle and quantum radiation. A simple method for the mechanical and chemical preparation is described. The foils are gas tight, smooth, and withstand a considerable pressure. A formula describes the relation between breaking pressure, diameter, and thickness for circular shaped foils.

533.6.011.31

117. ON VELOCITY AND TEMPERATURE DISCONTINUITIES NEAR THE WALLS OF A BODY AROUND WHICH RAREFIED GASES MOVE WITH VELOCITIES NEAR TO OR LARGER THAN THAT OF SOUND. M.F.Shirokov.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1490-5 (1958). In Russian.

Some new and more general formulae are deduced for the velocity and temperature discontinuities on the gas–wall surface for rarefied gas flows with arbitrary values of the Mach number. The formula for the velocity jump is practically the same as that for $M \ll 1$. On the other hand the formula for the temperature jump significantly differs from the well-known Maxwell formula for a gas at rest near the wall.

MOLECULAR THEORY OF GASES

533.7

118. MASS SPECTROMETRIC STUDY OF FERROUS CHLORIDE VAPOR. R.C.Schoonmaker and R.F.Porter.
J. chem. Phys., Vol. 29, No. 1, 116-20 (July, 1958).

Mass spectrometric studies of the vaporization process of ferrous chloride show that the major vapour species is monomeric $FeCl_2(g)$. A small concentration of $Fe_2Cl_4(g)$ is present in the vapour at low temperatures. The ratio of dimer to monomer concentration increases rapidly with temperature showing that at the melting point of $FeCl_2(s)$, the equilibrium vapour consists of about 25% dimer. Thermodynamic treatment of ion current data yields for the reaction

$$2FeCl_2(s) = Fe_2Cl_4(g), \Delta H^0_{640\,^0K} = 56 \pm 3 \text{ kcal/mole of dimer,}$$

and for the reaction

$$Fe_2Cl_4(g) = 2FeCl_2(g), \Delta H^0_{640\,^0K} = 32 \pm 3 \text{ kcal/mole of dimer.}$$

533.7 : 533.16 : 536.2.02

119. APPROXIMATE FORMULAS FOR THE VISCOSITY AND THERMAL CONDUCTIVITY OF GAS MIXTURES. R.S.Brokaw.
J. chem. Phys., Vol. 29, No. 2, 391-7 (Aug., 1958).

Approximate expressions for the viscosity and thermal conductivity of gas mixtures are derived from the rigorous kinetic theory formulae. Three levels of approximation are distinguished, with the third approximation rigorous for binary mixtures. The first approximation for mixture viscosity is found to be very nearly equivalent to empirical expressions known heretofore. The first and second approximations for mixture conductivity are compared with rigorous calculations for binary mixtures of nonpolar gas pairs; the first approximation has an average error of 2.6% while the second approximation reduces this error to 0.5%. The second approximation accounts for the thermal conductivity of binary mixtures of polar and nonpolar gases. (It is assumed that the interchange of translational energy is abnormal for the polar–polar interaction).

533.7

120. SYMMETRY EFFECTS IN THE KINETIC THEORY OF GASEOUS PARA–ORTHO MIXTURES.
E.G.D.Cohen and M.J.Offerhaus.
Physica, Vol. 24, No. 9, 742-50 (Sept., 1958).

At very low temperatures, a mixture of gaseous para- and ortho-hydrogen, on account of the 9-fold degeneracy of the o-H_2 component, constitutes a 10-component mixture. The treatment of its transport properties by the Chapman–Enskog theory can be reduced to that of a binary mixture. In a 1 p-H_2 : 9 o-H_2 mixture, the viscosity and heat conductivity are those of a 10-fold degenerate simple gas, and there is no thermal diffusion. The results are extended to multi-component mixtures with components having degeneracies similar to that of o-H_2.

533.7

121. KINETIC THEORY OF THE IMPULSIVE MOTION OF AN INFINITE PLANE. E.P.Gross and E.A.Jackson.
Phys. of Fluids, Vol. 1, No. 4, 318-28 (July-Aug., 1958).

The half-range method of solution of the Boltzmann equation is used to give a kinetic theory treatment of the Rayleigh problem. In contrast to the Navier–Stokes' or Grad theories, the method yields exact results for the initial stress and slip velocity at the boundary. It also indicates corrections to the classical Rayleigh results, even at long times compared to the collision periods of the gas molecules. The corrections are shown to be related to the usual slip boundary conditions of hydrodynamics plus an additional part arising from boundary layer effects. The half-range method predicts corrections to the standard methods of between 10-25% for all values of the time.

533.7

122. INTERACTION BETWEEN DIFFUSION AND VISCOUS FLOW IN MIXTURES OF RARIFIED MONOATOMIC GASES.
B.Baranowski.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 44, No. 7, 647-60 (1958).

Grad's method (Communications on Pure and Applied Mathematics, Vol. 2, 331, 1949) of solution of the Boltzmann equation is extended to two-component mixtures. The moment equations are derived describing the interaction between viscous flow and diffusion. The order of magnitude of mixture separation, due to the above interaction, is estimated. It is shown that the given results cannot explain the "streaming-diffusion" effect observed in gaseous mixtures.

533.72

123. ON THE KINETIC THEORY OF GASES AND THE TRANSPORT PHENOMENA IN THE GAS PHASE. L.Andrussow.
Naturwissenschaften, Vol. 44, No. 23, 611 (1957). In German.

The quadratic term of thermal velocity in the equation for the auto-diffusion coefficient can appreciably affect the numerical value of this coefficient. The author calculates the mean velocity of a particle of atomic weight 1, at 273.1^{0}K, as 2.61×10^5 cm/s. Auto-diffusion coefficients can also be calculated from thermal conductivity measurements at constant pressure. The interdiffusion of binary gas mixtures can be treated on the basis of their individual thermal velocities. R.Schnurmann

VIBRATIONS. ACOUSTICS

534

124. FOURTH ALL-UNION ACOUSTICS CONFERENCE, MOSCOW, USSR, MAY 26-JUNE 3, 1958. R.T.Beyer.
J. Acoust. Soc. Amer., Vol. 30, No. 10, 986-7 (Oct., 1958).

Report of this conference held at Moscow State University under the joint sponsorship of the Commission on Acoustics of the Academy of Sciences U.S.S.R., the Acoustics Institute of the Academy, and the Physics Faculty of the Moscow State University. Papers were presented in the following seven areas of interest: propagation of sound in inhomogeneous media, nonlinear acoustics, radiation and diffraction of sound, ultrasonics, electro-acoustics, acoustical measurements and architectural acoustics. H.D.Parbrook

534.121.2

125. ON THE VIBRATIONS OF TRIANGULAR MEMBRANES. S.K.Lakshmana Rao.
J. Indian Inst. Sci. B, Vol. 38, No. 1, 1-3 (Jan., 1956).

534.13

126. EXACT ANALYSIS OF THE PLANE-STRAIN VIBRATIONS OF THICK-WALLED HOLLOW CYLINDERS. D.C.Gazis.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 786-94 (Aug., 1958).

The plane-strain vibrations of a thick-walled hollow cylinder are investigated on the basis of the linear theory of elasticity. Approximate expressions for the frequencies of free modes are derived for moderately thick shells. The transition from the shell vibrations to the Pochhammer vibrations of a solid cylinder was investigated by means of a numerical solution of the frequency equation using an I.B.M. 704 digital computer.

534.131

127. ON THE CONSTRUCTION OF SCHEMATIC DIAGRAMS FOR MECHANICAL [VIBRATING] SYSTEMS. H.M.Trent.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 795-800 (Aug., 1958).

534.133

128. GRAVEST CONTOUR VIBRATION OF THIN ANISOTROPIC CIRCULAR PLATES. M.Onoe.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 634-8 (July, 1958).

In a previous paper (Abstr. 3071/1957), it was shown that the gravest mode of contour vibration of an isotropic thin circular plate has the circumferential order of two and is mostly equivoluminal in nature. Although the exact expression of the displacements includes Bessel functions, it can be reasonably approximated by a simple combination of trigonometric functions, which makes it possible to handle the anisotropic case. Since the mode is the gravest, Rayleigh's principle is applied in a procedure of approximation, taking an angle of rotation and a wave number as adjusting parameters. The results are compared with experiments of quartz vibrators. Calculated frequencies show agreement better than 1% with an exact value for isotropic plates and an observed value for a rotated Y-cut of quartz, which has a limited anisotropy. The accuracy decreases as the degree of anisotropy increases. For the X-cut of quartz, the calculated value is 4.7% higher than an observed value. One of the significant characteristics of the mode of vibration of an anisotropic plate is the fact that the direction of maximum displacement makes a certain angle with a crystallographic axis. The calculated value of this angle agrees exactly with the observed angle for the rotated Y-cut of quartz and within a few degrees for the case of the X-cut of quartz. Equivalent electric circuit constants and surface patterns of piezoelectrically induced charges are also calculated and compared with experiments.

534.133 : 534.21

129. ON THE ANGLE BETWEEN WAVE FRONT AND DISPLACEMENT OF PLANE ACOUSTIC WAVES IN QUARTZ. B. van der Veen.
Philips Res. Rep., Vol. 12, No. 4, 273-80 (Aug., 1957).

Generally, piezoelectric X-cut quartz plates are made rectangular. It is shown that, in general, a non-rectangular shape can give zero coupling to unwanted transverse vibrations. In this case it is necessary to compute the angle between the wave front and the displacement of plane acoustic waves in quartz.

534.152 : 535.417

130. STROBOSCOPIC INTERFEROMETER FOR VIBRATION MEASUREMENT.
E.R.Smith, S.Edelman, E.Jones and V.A.Schmidt.
J. Acoust. Soc. Amer., Vol. 30, No. 9, 867-70 (Sept., 1958).

This paper describes measurement of vibration amplitude with a Fizeau-type interferometer using pulses of monochromatic light of adjustable phase. The interferometer is used to calibrate vibration pickups over the frequency range from 100 to 20 000 c/s.

534.2 : 550.834

131. SURFACE AMPLITUDES OF REFLECTED BODY WAVES. L.Knopoff, R.W.Fredricks, A.F.Gangi and L.D.Porter.
Geophysics, Vol. 22, No. 4, 842-7 (Oct., 1957).

The components of the surface motions of a plane, free surface are computed for the incidence of plane body waves.

534.2 : 538.56

132. EXPERIMENTS ON CM WAVES IN ANALOGY WITH ACOUSTIC TECHNIQUES MADE IN GÖTTINGEN. E.Meyer.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 624-32 (July, 1958).

In the past four years a series of experiments was carried out which served to demonstrate the success of analogies between acoustical systems and electromagnetic wave systems in the microwave frequency region. Measuring techniques in the two disciplines are compared, with particular emphasis on the use of reverberation chambers. Analogous directive microphones and electromagnetic devices were constructed. The design and performance of absorbing structures of both nonresonant and resonant types is discussed at length.

534.2

133. ELASTIC WAVE SCATTERING AT A CYLINDRICAL DISCONTINUITY IN A SOLID. R.M.White.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 771-85 (Aug., 1958).

This study deals with the scattering of plane compressional and shear elastic waves incident obliquely on an infinitely long nondissipative cylindrical elastic discontinuity in an isotropic solid.

534.2 : 537.228.1

134. THEORY OF PLANE ELASTIC WAVES IN A PIEZOELECTRIC CRYSTALLINE MEDIUM AND DETERMINATION OF ELASTIC AND PIEZOELECTRIC CONSTANTS OF QUARTZ. I.Koga, M.Aruga and Y.Yoshinaka.
Phys. Rev., Vol. 109, No. 5, 1467-73 (March 1, 1958).

Atanasoff and Hart (Abstr. 469/1941) made a series of elaborate experiments in order to determine dynamically the elastic constants of quartz. However, they reported that in the evaluation of the elastic constants from the experimental data, there was a small but not easily explained discrepancy between theory and experiment. Lawson (Phys. Rev., Vol. 59, No. 10, 838, May 15, 1941) pointed out later that the piezoelectric effect could not be neglected in the dynamic determination of elastic constants. The present writers became aware that in the case of a plane elastic wave in a piezoelectric crystalline medium, only the component of piezoelectric polarization in the direction of wave propagation produces a restoring force against mechanical strain, as far as the piezoelectric effect is concerned. Thus the writers could derive the equation of a plane wave in a piezoelectric crystalline medium in general and could further determine the elastic and piezoelectric constants, together with their temperature coefficients, from experimental data. Various experimental results reported by the foregoing authors, including Atanasoff and Hart, can now be adequately explained, even at high temperatures, so that there is no longer any discrepancy between theory and experiments.

534.22 : 539.213.2

135. ULTRASONIC VELOCITY IN THE LIQUID–GLASS TRANSITION REGION. T.A.Litovitz and T.Lyon.
J. Acoust. Soc. Amer., Vol. 30, No. 9, 856-9 (Sept., 1958).

Ultrasonic measurements in two associated liquids, glycerol and Arochlor, show that the temperature coefficient of sound velocity in the glassy state is less than in the liquid. No discontinuity in the velocity data is observed at the "transition temperature". Using ultrasonic waves a "pseudo-transition" occurs at temperatures higher than the normal glass-transition temperature.

534.22 : 532.7

136. ULTRASONIC VELOCITIES IN SOME BI-UNIVALENT ELECTROLYTES. C.G.Balachandran.
J. Indian Inst. Sci. A, Vol. 38, No. 1, 1-9 (Jan., 1956).

Ultrasonic velocities and their variation with concentration up to 1 molar were measured for aqueous solutions of strontium iodide, lead acetate, uranyl chloride and uranyl nitrate at three different temperatures: 25°, 40° and 60°C. From the values of the velocities the apparent molar compressibilities were calculated. The effect is discussed of incomplete dissociation and the formation of complex ions on the slope of the curve of the apparent molar compressibility v. (concentration)$^{1/2}$.

534.22 : 532.7

137. SOUND VELOCITY IN A LENNARD JONES LIQUID MODEL. V.S.Venkatasubramanian.
J. Indian Inst. Sci. A, Vol. 37, No. 4, 227-31 (Oct., 1955).

An expression for the sound velocity is derived, using the partition function derived by Lennard-Jones. The dependence of velocity on chemical constitution is discussed, and the ultrasonic velocities are calculated for liquid gases for which the requisite data are available. There is fair agreement with experimental values.

534.22 : 532.7

138. ULTRASONIC VELOCITIES IN BINARY LIQUID MIXTURES NEAR THEIR CRITICAL SOLUTION TEMPERATURE. C.G.Balachandran.
J. Indian Inst. Sci. A, Vol. 38, No. 1, 10-15 (Jan., 1956).

An investigation was made of the variation of ultrasonic velocities and adiabatic compressibilities with temperature near the critical solution temperature of three binary liquid systems: water–isobutyric acid, phenol–water and aniline–cyclohexane. No anomalous change could be observed. Both velocity and adiabatic compressibility show a linear variation with temperature. Possible explanation for this behaviour is discussed.

534.22 : 532.7

139. APPLICATION OF THE FLORY MODEL TO SOUND VELOCITIES IN NORMAL PARAFFIN LIQUIDS. V.S.Venkatasubramanian.
J. Indian Inst. Sci. A, Vol. 38, No. 1, 23-5 (Jan., 1956).

An expression for the sound velocity is derived on the basis of a known statistical-mechanical theory of normal paraffin liquids. It is found that the variation of sound velocity among the members of the series is fairly well explained in terms of a factor denoting the number of elementary "cells" occupied by a molecule.

534.22 : 532.7

140. ULTRASONIC STUDIES IN ELECTROLYTE SOLUTIONS — SALTS OF HEAVY METALS. B.Krishnamurty and M.Satyanarayana Murty.
J. sci. industr. Res., Vol. 17B, No. 6, 216-18 (June, 1958).

Ultrasonic velocities in aqueous solutions of the salts of some heavy metals (lead, thallium, thorium and uranium) were determined at varying concentrations. Based on these determinations, the adiabatic compressibilities of the solutions were calculated. The ultrasonic velocities were found to decrease with increasing concentration of the salts in the solutions, contrary to the general variation of ultrasonic velocities in the case of other salts, which show an increase in velocity. Ultrasonic velocities determined in a solution of a mixture of lead nitrate and acetate are lower than those obtained in solutions of individual salts. This confirms the view that the decrease in ultrasonic velocity in solutions of these salts is due to the presence of heavy metal ions.

534.22

141. ULTRASONIC DISPERSION IN PALMITIC ACID. C.Raghupati Rao.
Ricerca sci., Vol. 28, No. 10, 2106-11 (Oct., 1958).

Ultrasonic velocities were measured at various frequencies and sound intensities, using a light modulator to view a plane progressive sound field. Measurements were made at 2 and 4 Mc/s, in the intensity range from 0.8×10^{-2} to 8×10^{-2} W/cm^2, and in the temperature range from 60° to 85°C. Intensity measurements were made with the help of a freely suspended pendulum in the ultrasonic beam. The accuracy of the experimental set up was tested with acetic acid. No detectable dispersion was observed in palmitic acid, either with frequency or with intensity. The temperature coefficient of velocity obtained by this method agrees well with the value reported in the literature.

534.222.2

142. NATURE AND PROCESS OF FORMATION OF SHOCK WAVES INITIATED BY DETONATION OF AN EXPLOSIVE. J.Kieffer, J.Dapoigny and B.Vodar.
C.R. Acad. Sci. (Paris), Vol. 247, No. 5, 577-80 (Aug. 4, 1958).
In French.

The possibilities of shocks of respectively greater or less velocity than the detonation wave (e.g. in penthrite) are discussed for a variety of substances whose experimental Hugoniots are given. In all cases the latter should take place, although at extremely high pressures the former may come into play for heavier substances.

P.Gray

534.222.2 : 536.71

143. EXPLOSIVE INDUCED SHOCK WAVES. I. PLANE SHOCK WAVES. II. OBLIQUE SHOCK WAVES. W.E.Drummond.
J. appl. Phys., Vol. 28, No. 12, 1437-41 (Dec., 1957); Vol. 29, No. 2, 167-70 (Feb., 1958).

The explosive production of shock waves in solids is analysed in the approximation that third and higher order terms in the shock strength can be neglected, and a procedure is developed for calculating the attenuation of the shocks. Application is made to the problem of determining the equation of state of the burned explosive gas.

534.23 : 533.7

144. ULTRASONIC DISPERSION AND ABSORPTION IN N-HEXANE VAPOR. J.Z.Klose.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 605-9 (July, 1958).

The velocity of high-frequency sound waves in n-hexane vapour at 35.15°C was measured at frequencies of 998.5 kc/s and 687.0 kc/s, and at pressures ranging from 1.10 to 12.28 cm Hg, using an ultrasonic interferometer. The dispersion which was detected in the velocity is attributed to the slow rate of energy exchange between the translational and vibrational states of the molecule. Although the upper limiting sound velocity could be reached experimentally owing to weak response at low pressures and strong absorption at high frequencies, it was established that the inflection point in the velocity v. frequency/pressure curve lay at 137 Mc/s atm^{-1}. This corresponds to a relaxation time of 6.46×10^{-9} sec at one atmosphere if it is assumed that there is only a single dispersion region involving the relaxation of the vibrational modes as a unit. Finally, a value of 127 was found for the average number of collisions necessary to deactivate the n-hexane molecule. Measurements of the amplitude absorption coefficient were also carried out and the relaxation time derived from these measurements.

534.23

145. ULTRASONIC ABSORPTION IN [PURE] BUTYRIC ACID. P.White and G.C.Benson.
Canad. J. Chem., Vol. 36, No. 8, 1135-7 (Aug., 1958).

The absorption was measured by a pulse technique from 0° to 40°C, and values of the relaxation frequency obtained. The activation energy of the relaxation process is shown to be 1.1 kcal/mole. These results are compared with published values for acetic and propionic acids, and possible relaxation processes discussed.

534.23 : 532.7

146. ULTRASONIC ABSORPTION IN LIQUIDS. I. M.Mokhtar and H.Youssef.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 549-51 (June, 1958).

The absorption of ultrasonic waves is measured for five nonassociated and five associated liquids at different temperatures extending between their freezing and boiling points. The absorption is measured by an electrodynamic balance specially developed for this purpose and explained in a previous paper (Abstr. 7231/1956). No relaxational processes were detected by varying the temperature. The thermal coefficient of absorption $(1/\alpha)(\partial\alpha/\partial t)$ is not constant for any liquid, but it varies with temperature. Moreover, its behaviour changes from one liquid to another. Such behaviour, if plotted on normalized scale of temperature (between freezing and boiling points), instead of ordinary scale, brings all nonassociated liquids to one common line given by $(1/\alpha)(\partial\alpha/\partial t) = c_1 t_N^{\frac{3}{2}}$, and all associated liquids to another common line given by $(1/\alpha)(\partial\alpha/\partial t) = = c_2 t_N + c_3$, where t_N is the normalized temperature. The constants c_1, c_2, c_3 do not depend on the nature of any particular liquid used. Thus these equations may be condisered as "reduced equations of absorption".

534.23

147. SOUND ABSORPTION AT 50 TO 500 kc FROM TRANSMISSION MEASUREMENTS IN THE SEA. S.R.Murphy, G.R.Garrison and D.S.Potter.
J. Acoust. Soc. Amer., Vol. 30, No. 9, 871-5 (Sept., 1958).

The absorption coefficient of sound in sea water was obtained by a series of direct transmission measurements at several moderately high frequencies in a sheltered deep water bay in Puget Sound. Advantage was taken of the isothermal and isosaline properties existing during certain seasons of the year in this location. The fluctuations normally encountered in such a measurement were minimized by the utilization of fixed buoys, a radio link for range determination by acoustic travel time, and a method of space averaging. Values obtained, in decibels per kiloyard at a temperature of 10°C and a salinity of 30 parts per thousand, are: 14.4 ± 0.3 at 60 kc/s,

35.7 ± 0.7 at 142 kc/s, 57 ± 3 at 272 kc/s, and 101 ± 3 at 467 kc/s. Although the frequency dependence of the absorption coefficient given by these measurements follows the normal relaxation law, the magnitudes are lower than those given by Del Grosso by 4 to 10 dB per kiloyard.

534.23

148. ORIENTATION DEPENDENCE OF ULTRASONIC ATTENUATION IN ZINC. P.C.Waterman.
J. appl. Phys., Vol. 29, No. 8, 1190-5 (Aug., 1958).

The attenuation of plane elastic waves in the megacycle region is investigated for several different propagation directions in single crystalline zinc. Results are in qualitative agreement with the losses predicted theoretically due to dislocation damping and thermoelastic effects. Losses not accounted for by the available theory are observed.

534.23

149. ULTRASONIC ABSORPTION IN $MnSO_4$ SOLUTIONS. S.K.Kor and G.S.Verma.
J. chem. Phys., Vol. 29, No. 1, 9-14 (July, 1958).

The absorption was studied in great detail in the frequency range 1-6 Mc/s, at concentrations varying from 0.0025 to 1 molar. The relationship between the excess sound absorption and the concentration is found to be linear from 0.02 to 0.1 molar, but becomes non-linear both below 0.02 and above 0.1 molar. The frequency behaviour of the excess sound absorption can be represented by a relaxation curve at about 3 Mc/s. The mechanism responsible for excess sound absorption is of the dissociation type which is confirmed by a study of the influence of the dielectric constant of the solvent on the absorption and the temperature shift of the relaxation frequency.

534.23

150. SOUND ABSORBING PROPERTIES OF INDIGENOUS MINERAL WOOL. M.Pancholy and B.S.Atal.
J. sci. industr. Res., Vol. 17B, No. 7, 239-41 (July, 1958).

The sound absorption coefficient and specific acoustic impedance were determined over the frequency range 100-5000 c/s. This material compares favourably, in its sound absorbing properties, with some varieties of rockwool and could be utilized for sound insulation purposes.

534.23 : 532.7

SOUND ABSORPTION IN RELATION TO FREE VOLUME OF LIQUIDS. See Abstr. 102

534.23.08

151. TWO-CRYSTAL INTERFEROMETRIC METHOD FOR MEASURING ULTRASONIC ABSORPTION COEFFICIENTS IN LIQUIDS. R.S.Musa.
J. Acoust. Soc. Amer., Vol. 30, No. 3, 215-19 (March, 1958).

Methods for measuring α, the sound amplitude absorption coefficient in liquids, using two matched quartz crystals are outlined. A standard signal generator drives one of the crystals continuously. The amplitude of the resulting pressure waves is measured at the other crystal by means of a communications receiver and a voltmeter. Partial wave analysis allows the voltage observed at the second crystal to be expressed in terms of the absorption coefficient. Three cases are identified: low, high, and intermediate absorption, and the above expression is simplified for each of these cases. Data, obtained by these methods, are presented. The internal consistency encountered suggests an accuracy of ±3%.

534.232

152. DYNAMIC MECHANICAL STABILITY IN THE VARIABLE-RELUCTANCE AND ELECTROSTATIC TRANSDUCERS. C.H.Sherman.
J. Acoust. Soc. Amer., Vol. 30, No. 1, 48-55 (Jan., 1958).

Large displacement behaviour of the variable-reluctance and the mathematically equivalent electrostatic, transducing mechanism was analysed in order to evaluate the importance of mechanical instability as a limiting factor in high-power sound projectors. Previous work by Hunt et al. had shown the existence of static instability. This paper first considers the effect of transients on static stability and then shows that instability can also occur under steady-state dynamic conditions even when the system is statically stable. When the excitation is increased in order to increase the amplitude of the oscillations, the average displacement also increases, which leads to collapse of the gap. This interdependence of the oscillatory motion and the average displacement, intentionally excluded from linearized treatments, is the cause of dynamic instability. Detailed calculations show the conditions for instability for typical values of mechanical Q, polarization, and frequency. Under steady-state dynamic conditions the average displacement can exceed the static limit of $\frac{1}{3}$ the gap length, and the relative oscillatory displacement amplitude can reach $\frac{1}{2}$ or more without collapse.

534.232 : 534.321.9

153. ULTRASONIC ENERGY GENERATED BY SANDBLAST. E.E.Suckling.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 803 (Aug., 1958).

A blast of sand on a steel plate produces ultrasonic radiation detected by a quartz crystal.

534.26

154. ON THE DIFFRACTION OF SOUND WAVES IN A VISCOUS MEDIUM. J.B.Alblas.
Appl. sci. Res. A, Vol. 6, No. 4, 237-62 (1957).

The theory of the diffraction of a sound wave at a half-plane barrier is extended to the case of propagation in a viscous medium. It is shown that the singularity in the velocity near the edge of the barrier, a characteristic feature of the classical second-order theory, disappears. In the neighbourhood of the edge the velocity attains its maximum, the value of which is determined by a reciprocal power of the viscosity. In the far field a viscous wave occurs, the amplitude of which is proportional to the square root of the viscosity, in contrast to the second-order theory, where the introduction of a viscosity gives rise to a linear dependence.

534.321.9

155. ULTRASONIC REFLECTOSCOPE WITH AN INDICATOR OF THE DEGREE OF COUPLING BETWEEN TRANSDUCER AND OBJECT. A.Lutsch.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 544-8 (June, 1958).

A further development of Firestone's reflectoscope is described, indicating the degree of coupling between transducer and the test object. It is shown that the distortion of a radio-frequency pulse — produced by the transducer — is a function of its coupling to the test object. Therefore, the distortion can be used to measure the coupling. The trailing edge of the radio-frequency pulse is amplified by a time-selective amplifier, rectified and connected to a galvanometer. Different conditions of coupling are analysed. Figures are given for a barium titanate transducer working at 500 kc/s. References such as back boundaries are no longer necessary in the field of nondestructive testing.

534.39

156. RADIATION FORCE ON BODIES IN A SOUND FIELD. H.Olsen, W.Romberg and H.Wergeland.
J. Acoust. Soc. Amer., Vol. 30, No. 1, 69-76 (Jan., 1958).

A simple derivation of the force which acts on a body placed in sound field is given. The tensor properties of the force are exhibited, but it is also shown that for a rigid body the force may be derived from the scalar pressure alone. It is shown how the time average force is determined by the momentum lost by the sound wave during the collision with the body. Using this result, the force is related to the scattering amplitude, and a simple expression in terms of the phase shifts is given. The connection between the force and the scattering cross-section is examined. A force factor

$$\kappa = \bar{K}_z/(\tfrac{1}{2}\rho_0 k^2 \sigma_{sc})$$

is defined. It is shown that $\kappa = 1$ for plane scatterers at perpendicular incidence. A simple general formula for the force in the limit of short wavelengths is derived. It is shown that neither for very long wavelengths nor for very short ones is κ in general equal to 1. The case of a rigid sphere is treated in detail. Curves are shown for the force and for the force factor κ.

534.39

157. SMALL SCALE ACOUSTIC STREAMING NEAR A LOCALLY EXCITED MEMBRANE. F.J.Jackson and W.L.Nyborg.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 614-19 (July, 1958).

Experiments are described involving a membrane set into oscillatory motion (40 kc/s) by contact with a vibrating tip of small area. Small scale acoustic streaming is observed in a liquid above the membrane, especially near the area of contact; its character depends on the membrane tension. Loosely adhering films are removed from certain areas of the membrane. The cleared areas form a pattern, indicative of the surface stress distribution set up by the eddying liquid. The main features of the reported results are accounted for, at least, qualitatively, by the application of acoustic streaming theory to idealized cases. The possibility is discussed of motion induced in biological cells by external vibrating bubbles.

534.39

158. TORQUES DUE TO ACOUSTICAL RADIATION PRESSURE. G.Maidanik.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 620-3 (July, 1958).

A general expression for the torque on an object due to acoustical radiation pressure is derived by an approach similar to that used by Westervelt (Abstr. 4086-1957) to derive the general expression for the force. The general expression is then specialized to plane waves incident in an arbitrary direction. The simplification that is obtainable in the case of disks is also discussed.

534.39

159. ACOUSTIC RADIATION FORCE. H.Olsen, H.Wergeland and P.J.Westervelt.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 633-4 (July, 1958).

A formula for the force on an arbitrary scatterer is derived without making any assumptions about the scatterer.

534.7

PHYSIOLOGICAL ACOUSTICS. HEARING. See also the Section entitled "BIOPHYSICS. PHYSIOLOGICAL PHYSICS".

534.784 : 612.85

160. PITCH DISCRIMINATION FOR SYNTHETIC VOWELS. J.L.Flanagan and M.G.Saslow.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 435-42 (May, 1958).

A psycho-acoustic experiment to determine the just-discriminable changes in the fundamental frequency of synthetic vowels is described. The experimental parameters investigated are several combinations of four vowels (|i, æ, a, u|), three sound pressure levels (60, 70 and 80 dB re 0.0002 dyn/cm^2) and two fundamental frequencies (80 and 120 c/s). The results indicate that the just-discriminable changes in fundamental frequency are of the order of 0.3 to 0.5 c/s, and are, in general, slightly less than the frequency changes discriminable in a pure tone of the same frequency and sound pressure level. Application of the results to speech compression is suggested.

534.831

161. EFFECT OF NOISE ON AN "INTELLECTUAL" TASK. D.E.Broadbent.
J. Acoust. Soc. Amer., Vol. 30, No. 9, 824-7 (Sept., 1958).

Three groups of naval ratings worked for two sessions each at a subtraction task involving a considerable immediate memory load. One group had both sessions in relative quiet (70 dB), a second had the first session in 100 dB noise and the second in quiet, and the third group had noise and quiet in the reverse order. In the first session the noise group slowed down at solving the subtractions as time went on, relative to the groups working in quiet. A similar difference appeared in the second session, but, in addition, there was an aftereffect of noise such that the subjects who had had noise previously slowed down relative to those who had not. Slowing down of performance with time was in all groups most marked in extroverts. These results suggest firstly that intellectual work as well as simple sensory tasks must be regarded as endangered by noise. Secondly, there may be harmful aftereffects from noise, but it is not clear whether these will appear in any situation or only in one similar to that in which the noise was experienced.

534.839

162. EXPERIMENTAL COMPARISON BETWEEN NOISE FROM UNHEATED SUBSONIC AIR JETS HAVING 4 : 1 ELLIPTIC AND CIRCULAR ORIFICES. A.Powell.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 642-3 (July, 1958).

This note describes a short series of experiments investigating the nature and magnitude of the differences in the noise field from subsonic cold air jets having circular and elliptic orifices. An anticipated increase in the noise level occurs in directions normal to the major axis, but other changes having more obscure origins are also revealed.

534.839

163. MEASUREMENT OF NOISE SOURCES IN DUCTS. I.Dyer.
J. Acoust. Soc. Amer., Vol. 30, No. 9, 833-41 (Sept., 1958).

Recently Kerka, Amer. Soc. Heating Air Conditioning Engrs. J. Sec. of Heating, Piping Air Conditioning, Vol. 29, 139-46 (April, 1957), and earlier Beranek, Reynolds, and Wilson (Abstr. 3069/1953), discussed the measurement of sound power radiated by a fan in a straight duct, by measurements of the sound pressure inside the duct. A difficulty associated with this technique is that above a certain frequency the sound pressure varies markedly across a transverse section of the duct and the relation between mean square pressure and power is not simple. The transverse variation can be understood by application of mode theory to propagation of noise in the duct. In the theory it is assumed that the noise source is purely random and of low internal impedance. Propagation in the various duct modes is shown to be statistically independent, and to give rise to equipartition of energy in the limit of high frequencies. The theory agrees well with measurements reported by Kerka. With the use of the theory, it is possible to select measurement positions inside the duct such that the mean square pressure is related to the power flow by the simple plane-wave equation.

OPTICS. SPECTRA. LUMINESCENCE

535.1 : 530.12

PROPAGATION OF LIGHT IN A GRAVITATIONAL FIELD. See Abstr. 24

535.14

164. PHOTON CORRELATION IN COHERENT LIGHT BEAMS. E.Brannen, H.I.S.Ferguson and W.Wehlau.
Canad. J. Phys., Vol. 36, No. 7, 871-4 (July, 1958).

Experiments were carried out in an attempt to detect any correlation between photons in coherent light rays using a coincidence circuit of resolving time $2\tau = 8 \times 10^{-9}$ sec. A Hg 198 electrodeless discharge tube under r.f. excitation was used to provide an intense monochromatic source of narrow line width (0.006 and 0.009 A) at 5461 A. A positive correlation was detected and compared with theoretical predictions.

535.241.39

165. MEASUREMENTS WITH THE ULBRICHT SPHERE. K.Stolzenberg.
Lichttechnik, Vol. 10, No. 10, 518-20 (Oct., 1958). In German.

Describes experiments on the effect of (a) the cosine error of the receptor, (b) the size of the screen,and (c) the light distribution of the source, on measurements of luminous flux made in a 1.5 m sphere. A curve is given to show the relation between the error made in measuring a tubular fluorescent lamp and the length of the lamp expressed as a fraction of the diameter of the sphere. It is concluded that the conditions of measurement laid down in DIN 5032 are satisfactory in practice. J.W.T.Walsh

535.313.2

166. DISTRIBUTION OF RADIATION FROM ELLIPTICAL AND PARABOLIC MIRRORS. P.J.Hart.
J. Opt. Soc. Amer., Vol. 48, No. 9, 637-42 (Sept., 1958).

A method is described for determining the distribution of the radiation reflected from a mirror due to a point source. In particular, the distribution from an elliptical cylinder, which apparently has not been previously analysed, is investigated and examples are given of the irradiance on surfaces of various configurations. In addition, the distribution from mirrors of ellipsoidal, paraboloidal, and parabolic cylinder form is considered. The method used may be extended to other types of mirrors.

535.316

167. A CONTRIBUTION TO THE SEIDEL THEORY OF THE THIN-LENS TRIPLET. G.Kirchhof.
Optik, Vol. 14, No. 9, 388-98 (Sept., 1957). In German.

Given the total power, the power of the first component, the three refractive indices, the stop position and the sum of the separations, explicit solutions are obtained for zero coma, astigmatism, field curvature and distortion. The spherical aberration is computed as a function of the power and position of one component, and thus all possible solutions are obtained. W.T.Welford

535.317 : 538.566 : 621.396.677.85

168. ON THE AXIAL PHASE ANOMALY FOR MICROWAVE LENSES. G.W.Farnell.
J. Opt. Soc. Amer., Vol. 48, No. 9, 643-7 (Sept., 1958).

The behaviour of the phase along the axis of aberration-free microwave lenses is shown by curves of the axial phase anomaly calculated from scalar Kirchhoff diffraction theory. These curves are drawn for three different wavelengths and two typical focal lengths. Also illustrated in the calculated results are the errors introduced by the use of certain geometrical approximations commonly employed in light optics. Detailed experimental measurements were made of the electric field along the axis in the point-source image produced by solid dielectric lenses at a wavelength of 3.2 cm. Despite the limited size of the exit pupil (radius approximately 8 wavelengths) the agreement between the measured values of

the axial phase anomaly and those calculated from scalar theory is very good except within about one lens radius of the lens surface.

535.317.2

169. THE THEORY OF ASTIGMATIC BIFOCAL SPECTACLE LENSES. J.Flügge.
Optik, Vol. 14, No. 5, 193-201 (May, 1957). In German.

The position of the optical centre of the reading portion of an astigmatic bifocal lens is found as a function of the refractive index and the axis of the cylinder. The prismatic deviation in various parts of the reading lens is also calculated. R.W.Fish

535.317.5

170. THE INFLUENCE OF SPHERICAL ABERRATION ON THE RESPONSE FUNCTION OF AN OPTICAL SYSTEM. A.M.Goodbody.
Proc. Phys. Soc., Vol. 72, Pt 3, 411-24 (Sept., 1958).

The integral expressing the frequency response of an optical system in different focal planes in the presence of primary and secondary spherical aberration was evaluated for a large number of cases employing a DEUCE computer. Detailed results are given for values of the secondary spherical (wave front) aberration $w_{60} = -4\lambda, -6\lambda, -9\lambda, -12\lambda$, each with three different amounts of primary aberration and each in five different focal planes; and curves are given showing the frequency response that can be obtained when the performance is optimized for low frequencies according to Hopkins' criterion, where a low frequency is one for which the response is greater than or equal to 0.8. For these low frequencies it is confirmed that an under-corrected marginal ray gives the best image quality. For frequencies greater than that for which the response is approximately 0.6, an over-corrected margin is to be preferred. It is found that, in agreement with the prediction of geometrical optics, the values of the response, $D(s,\psi)$, plotted as functions of the product sw_{60} (or sw_{40}, for the case $w_{60} = 0$), where s is the reduced spatial frequency, lie closely on a single curve, when $sw_{60} \leq 1.2$ (or $sw_{40} \leq 0.3$, for $w_{60} = 0$).

535.323

171. THE DISPERSION OF THE PIEZO-OPTIC CONSTANTS OF VITREOUS SILICA. E.S.Jog.
J. Indian Inst. Sci. A, Vol. 39, No. 2, 101-7 (April, 1957).

The constants q_{11} and q_{12} were determined for various wavelengths in the range from 220 to 570 mμ. In this range the value of q_{11} increases from -0.24×10^{-13} to $+0.11 \times 10^{-13}$, while that of q_{12} increases from 2.35×10^{-13} to 2.49×10^{-13} c.g.s. units. The dispersion of these constants with wavelength was established. The values of $(q_{12} - q_{11})$ calculated from the observed values of the individual constants agree very well with those calculated from the measured values of the stress optical coefficient. The elasto-optic constants p_{11} and p_{12} and the change of refractive index with density were evaluated.

535.323

172. DISPERSION OF SOME OPTICAL GLASSES IN THE VISIBLE AND INFRARED.
G.F.Brewster, J.F.Kunz and J.L.Rood.
J. Opt. Soc. Amer., Vol. 48, No. 8, 534-6 (Aug., 1958).

Indices of refraction of a number of optical glasses are given for the wavelength region 0.4 μ to 2.5 μ. Dispersion curves for different glasses are more similar in the infrared than they are in the visible. Infrared indices may be calculated from measured values of indices in the visible for a particular glass if visible and infrared indices are known for two or more other glasses. The expected error in the calculated infrared index is less than one unit in the third decimal place if the glass is similar in composition to those whose indices were measured, and of the order of two in the third place if far different in composition.

535.323 : 535.55

173. SOME OPTICAL, THERMO-OPTICAL, AND PIEZO-OPTICAL PROPERTIES OF SYNTHETIC SAPPHIRE.
M.A.Jeppesen.
J. Opt. Soc. Amer., Vol. 48, No. 9, 629-32 (Sept., 1958).

Measurements of the ordinary and extraordinary refractive indexes of synthetic sapphire are reported. Direct independent measurements of the birefringence are given. Temperature and piezo-optical coefficients of birefringence are given and combined with published data and calculations of W.L.Bragg to yield order of magnitude values for the thermal coefficient of expansion and Young's modulus.

535.323

174. REFRACTIVE INDEX OF ARSENIC TRISULFIDE.
W.S.Rodney, I.H.Malitson and T.A.King.
J. Opt. Soc. Amer., Vol. 48, No. 9, 633-6 (Sept., 1958).

The refractive index of a sample of As_2S_3 was determined at three temperatures near 19°, 25° and 31°C for selected wavelengths in the range 0.57 μ to 11.8 μ. A five-term Sellmeier-type dispersion equation was fitted to the averaged data reduced to 25°C; four of the constants were chosen to approximate an absorption continuum in the ultraviolet and visible while the fifth term was arbitrarily chosen as beyond the infrared absorption edge. The indexes of refraction in the visible region of two other samples were obtained for comparison.

535.324 : 536.48

175. REFRACTIVE INDEX OF He^4 : LIQUID. M.H.Edwards.
Canad. J. Phys., Vol. 36, No. 7, 884-98 (July, 1958).

Changes in the phase refractive index n with temperature were measured between 1.6° and 4.2°K at 5462.27 A, for liquid He^4 at its saturated vapour pressure, using a metal optical cryostat and a Jamin interferometer. A novel adaptation of the Jamin interferometer was made so that, in addition, an absolute determination of the group refractive index n_G could be made using white light of "effective wavelength" 5595 ± 40 A. When the dispersion correction is made, the phase index for the Hg green line at $T_{55}E = 3.700°K$ is $n = 1.026\,124 \pm 0.000\,035$. The relative measurements were adjusted to this value. The more than 200 experimental points show a random scatter of less than 5×10^{-6} in index. Using Kerr's density data the polarizability is thus $(N_0\alpha) = (0.124\,54 \pm 0.000\,21)$ cm^3 mole^{-1} at 5462.27 A, for liquid He^4 at 3.7°K. Within experimental error $(N_0\alpha)$ is found to be independent of temperature. Thus the refractive index data may be considered as a measurement of the liquid density and coefficient of expansion. The region near the λ-point is of special interest. The expansion coefficient determined from the refractive index β_n may be represented within experimental error by

$$10^3\beta_{nI} = +41.5 + 14.5\left|\log T - T_\lambda\right|$$

for $T > T_\lambda$, from about 0.1° above T_λ to within 0.01° of T_λ; and by

$$10^3\beta_{nII} = -1.5 + 14.5\left|\log T - T_\lambda\right|$$

for $T < T_\lambda$, from about 0.1° below T_λ to within 0.002° of T_λ. This implies that the density–temperature curve has both a vertical tangent and a point of inflection at the λ-point; and that the maximum in density occurs about 0.001° above the λ-point.

535.325

176. OPTICAL DISPERSION OF GASES IN THE INFRARED.
J.H.Jaffe, M.A.Hirschfeld and S.Kimel.
J. chem. Phys., Vol. 29, No. 3, 675-6 (Sept., 1958).

The relationship between absorption and dispersion in the infrared is discussed. The dispersion through the lines R(2) of the 2–0 band of HCl^{35} and HCl^{37} was determined at two gas pressures using a hollow prism gas refractometer. G.I.W.Llewelyn

535.33 : 531.715 : 535.417

177. SOME CONSIDERATIONS ABOUT THE PRECISION OF THE INTERNATIONAL STANDARD OF WAVELENGTH.
Shang Yi Ch'en.
Amer. J. Phys., Vol. 26, No. 7, 464-6 (Oct., 1958).

The precision of the accepted value for the wavelength of the red line of Cd is discussed. The uncertainty due to the setting of the end marks by a microscope in the interferometric measurements, the correction for the refractive index of air, and the difficulty in controlling precisely the conditions of excitation of the light source are reviewed with considerations for a new standard of wavelength and a new pair of end marks.

535.33.03

178. IMPROVED, SINGLE FLASH, CONTINUUM SOURCE FOR USE BELOW 2000 A. J.A.Golden and A.L.Myerson.
J. Opt. Soc. Amer., Vol. 48, No. 8, 548-50 (Aug., 1958).

A high-intensity, low-energy flash lamp for use below 2000 A is described. The radiation from a single flash, at 4000 V and 15 μF, produces an emission continuum to 1500 A which is of sufficient intensity to be used with either photographic or photomultiplier techniques. A densitometer trace of the Schumann–Runge O_2 absorption band system is shown. Also, oscilloscope traces are presented which were taken at 1700 A. These show attenuation of the signal as a function of oxygen concentration.

535.33.07

179. A RECORDING UNIT FOR INFRARED SPECTRA FOR USE WITH A ZEISS MIRROR MONOCHROMATOR. H.Kindler.
Exper. Tech. der Phys., Vol. 4, No. 2, 62-9 (1956). In German.

A simple apparatus is described which can be used with a standard monochromator, to make it into a semi-automatic equipment. It consists of a chopper disk, bolometer, amplifier and pen recorder. Practical details of these are given and some results of typical investigations shown. R.W.Fish

535.33.07

180. METHODS FOR DETERMINING THE ADJUSTMENT OF MIRROR–PRISM MONOCHROMATORS. K.Lenz.
Exper. Tech. der Phys., Vol. 6, No. 3, 125-9 (1958). In German.

Optical systems containing a number of mirror and prism elements need to be accurately adjusted if the theoretical resolution is to be obtained. This paper reviews the results of various derangements in the case of monochromators and gives methods for finding the best adjustment. The methods are illustrated with typical results. R.W.Fish

535.33.07

181. THEORY OF A CONCAVE GRATING SPECTROMETER. H.Greiner and E.Schäffer.
Optik, Vol. 15, No. 1, 51-62 (Jan., 1958). In German.

When entrance and exit slits are fixed and the wavelength is changed by rotation of the grating, the spectrum becomes out of focus. The most favourable values (minimum defocusing) for the angle (θ) between entrance and exit directions and for the slit-grating distances (s) are calculated for several wavelength ranges; and if a different value of θ is preferred, the best values for s may also be calculated. G.F.Lothian

535.331 : 535.337

182. ZEEMAN EFFECT DATA FOR THE SPECTRA OF ERBIUM. J.W.Lindner and S.P.Davis.
J. Opt. Soc. Amer., Vol. 48, No. 8, 542-7 (Aug., 1958).

Zeeman effect data have been collected for 18 resolved patterns in the Er I spectrum, 201 resolved patterns in the Er II spectrum, and 205 unresolved patterns. The use of digital computers in the analysis of spectra is discussed and applied, in an attempt to break into term arrays of the erbium spectra. The electrodeless discharge source unit that was used is described.

535.331 : 539.14

183. ISOTOPE SHIFTS IN HAFNIUM. W.L.Barr.
J. Opt. Soc. Amer., Vol. 48, No. 9, 658-62 (Sept., 1958)

Isotope shifts are here reported for all stable isotopes of hafnium. The ratios found are: $\Delta\sigma(180-178):\Delta\sigma(178-176):\Delta\sigma(176-174) = 100:82.6\pm3.5:87.6\pm3.7$, and $\Delta\sigma(180-178):\Delta\sigma(180-179):\Delta\sigma(178-177) = 100:61\pm9:73\pm8$. The variation of the shifts with neutron number and the even–odd staggering are well beyond experimental error, and are therefore real. Magnitudes of the shifts observed in the spectral lines ranged from 29 to 46 mK. Centroids of the hyperfine-structure patterns due to the odd isotopes were located by using known ratios of the nuclear moments or of the hyperfine-structure parameters. The difference in the electric quadrupole moments between isotopes are discussed from the point of view of isotope-shift anomalies.

535.332

184. THE MEASUREMENT OF TRANSITION PROBABILITIES OF LINES IN NEUTRAL CARBON. J.Richter.
Z. Phys., Vol. 151, No. 2, 114-23 (1958). In German.

The absolute intensity of spectral lines of neutral carbon emitted from a CO_2 arc was measured in a optically thin layer. In addition to a few visible multiplets, fourteen in the near infrared were investigated. The resulting transition probabilities are approximately 30% below the values obtained from the methods of Bates and Damgaard (Abstr. 4640/1949). C.G.Morgan

535.333

185. SHAPE OF AN EMISSION LINE OF CH PRODUCED IN AN OXYACETYLENE FLAME.
D.H.Rank, G.D.Saksena and T.A.Wiggins.
J. Opt. Soc. Amer., Vol. 48, No. 8, 521-4 (Aug., 1958).

Interferometric measurements were made of the contour of an emission line at λ4226A produced by an oxyacetylene flame. This emission line is produced by the K-19 $R_{dc}(0,0)\,^2\Delta-^2\pi$ transition of the CH molecule. The line contour was observed by direct photoelectric intensity measurement of the interferometer pattern. It is found that the line contour and half-width is not consistent with Doppler broadening at any reasonable temperature. It must be concluded that very large collision broadening must be present in the CH flame thus making the determination of a translational temperature difficult. However the existence of a large amount of collision broadening would seem to show that a high probability of rotational equilibrium exists.

535.333

186. ULTRAVIOLET BANDS OF MERCURY BROMIDE. V.G.Krishnamurthy.
Z. Phys., Vol. 152, No. 2, 242-8 (1958).

The bands were excited in uncondensed discharge and photographed with a quartz Littrow spectrograph. The class II system, lying between 2900 and 2700 A was studied in detail and ascribed to the diatomic molecule. The bands in the region from 2900 to 2770 A were analysed into two systems which may form the two components of a $^2\Pi-^2\Sigma$ electronic transition with a $^2\Pi$ interval equal to 969.4 cm^{-1}. Another system, most probably due to $^2\Sigma-^2\Sigma$, was observed in the region from 2770 to 2720 A.

535.338.334 : 523.87

187. SHIELDING CORRECTION TO HOLTSMARK'S THEORY OF LINE BROADENING. H.Hoffman and O.Theimer.
Astrophys. J., Vol. 126, No. 3, 595-7 (Nov., 1957).

Preliminary results of a refinement of Holtsmark's theory of the statistical Stark effect by including Debye shielding effects are given in the form of graphs of the normal field distribution at 10 000° K for three ion concentrations (10^{15}, 10^{17}, and 10^{19} cm^{-3}). The "nearest neighbour" approximation is used but the results justify the more rigorous use of Markoff's method, which is being undertaken. G.A.Chisnall

535.338.4

188. INTERPRETATION OF THE ORIENTATION OF SPECTRAL BANDS EMITTED BY A TRANSITORY COMPLEX IN THE FIELD OF DISPERSION FORCES. R.Aynard.
C.R. Acad. Sci. (Paris), Vol. 247, No. 3, 281-3 (July 21, 1958). In French.

London dispersion is responsible for the bands shifted towards the red, as is expected by theory, but only down to a certain limiting distance between the two states of the complex. The energy due to the triple collision between the complex and a neighbouring atom for smaller distances is responsible for the bands shifted towards the violet. C.Turner

535.34

189. MODELS FOR SPECTRAL BAND ABSORPTION. G.N.Plass.
J. Opt. Soc. Amer., Vol. 48, No. 10, 690-703 (Oct., 1958).

An exhaustive, theoretical study is made of the various models that were proposed to represent band absorption. These models are compared with each other; a derivation is given of the regions where they predict the same absorption. The regions of validity for various useful approximations to these models are also given. The statistical model is extended to include the random superposition of a finite number of Elsasser bands (Abstr. 3730/1938). Thus a continuous spectrum of absorption curves is obtained between the results for the Elsasser and the pure statistical models. The absorption predicted by the statistical model when there is a specific number of spectral lines in the frequency interval under consideration is compared with the limit as the number of lines approaches infinity. It is shown that the shape of the absorption curves obtained from the statistical model is independent of the distribution of line intensities in the band for most cases of interest. The absorption from the statistical model including the effects of overlapping is shown to depend only on an average equivalent width for a single line. This result is used to derive the band absorption for the statistical model with Lorentz, Doppler, and other line shapes.

535.34

190. THEORY OF RYDBERG SERIES IN MOLECULAR SPECTRA. A.D.Liehr.
Z. Naturforsch., Vol. 11a, No. 9, 752-6 (1956).

A method is given for calculating term values for the molecular Rydberg series. The formulae thus derived are applied to a calculation of the benzene and ethylene term values.

535.34

191. EFFECT OF CONVERGENCE ON THE INFRARED SPECTRA OF ANISOTROPIC SUBSTANCES.
D.L.Wood and S.S.Mitra.
J. Opt. Soc. Amer., Vol. 48, No. 8, 537-42 (Aug., 1958).

Two examples of the effect on infrared spectra of convergence of the light-beam traversing a sample are presented. In the first case a sample has absorbing dipoles oriented parallel to a unique axis and randomly oriented in a plane perpendicular to that axis. The incident radiation is perpendicular to the unique axis. Such samples are shown to have slightly different dichroic ratios for convergent radiation than for parallel radiation. An error in the literature concerning this case is pointed out. In the second case a uniaxial crystal having absorbing dipoles parallel to the unique axis is shown to absorb convergent radiation when the radiation comes toward the sample along the unique axis. This absorption which is not observed for parallel radiation may reach a maximum of 53 to 56% depending on the degree of convergence, the thickness of the sample, and the strength of the absorbing dipole. The frequency of the band observed because of the effect of convergence may also be appreciably higher than that for the allowed transition.

535.34.07

192. A RECORDING SPECTROPHOTOMETER FOR THE ULTRAVIOLET, VISIBLE AND NEAR INFRARED REGION.
G.Geppert.
Exper. Tech. der Phys., Vol. 6, No. 2, 79-84 (1958). In German.

Radiation from a quartz prism monochromator, chopped at 1000 c/s, is alternated at 12.5 c/s through the specimen and comparison cells to a photomultiplier or PbS cell. The amplified output from the comparison beam is used to control the entrance slit to constant energy. Records showing performance are given.
G.F.Lothian

535.34.07

193. A MICROWAVE SPECTROMETER FOR THE STUDY OF FREE RADICALS. I.R.Hurle and T.M.Sugden.
J. sci. Instrum., Vol. 35, No. 9, 319-23 (Sept., 1958).

A microwave spectrometer suitable for the study of short-lived molecules in the gas phase, in particular free radicals, was constructed to operate over a frequency range from about 20 to 70 kMc/s. An innovation is the use of surface-wave propagation of the microwaves along a wire in the absorption cell, a system which has very wide band-pass properties. High sensitivity is obtained by using a radio-frequency modulation of the klystron source. The apparatus is described in detail, with some account of the underlying principles, and preliminary results with the short-lived substance carbon monosulphide are presented.

535.34.07

194. STARK-EFFECT, RESONANT CAVITY MICROWAVE SPECTROGRAPH. P.H.Verdier.
Rev. sci. Instrum., Vol. 29, No. 7, 646-7 (July, 1958).

A K-band microwave spectrograph is described which employs a Stark-modulated resonant cavity as an absorption cell. The cavity is in the form of a circular cylinder of variable length, operating in the TE_{01p} modes. The modulating field is parallel to the cylinder axis, and is sufficiently uniform to permit the resolution of Stark components. The sensitivity of the cavity spectrograph is comparable with that of a waveguide spectrograph.

535.34.07

195. A RADIO-SPECTROSCOPE FOR THE INVESTIGATION OF MOLECULAR ROTATION SPECTRA. T.M.Murina.
Radiotekhnika i Elektronika, Vol. 2, No. 10, 1271-8 (1957). In Russian.

A radio-spectroscope of high sensitivity operating in the 10 to 43 Gc/s band is described. Details are given of the klystron frequency stabilizer, the method of measuring the frequency of spectral lines and of a Stark modulator.
R.C.Glass

535.343 : 537.311.33

196. MODULATION OF INFRARED RADIATION IN GERMANIUM AT LOW TEMPERATURES. Yu.I.Ukhanov.
Zh. tekh. Fiz., Vol. 27, No. 8, 1652-4 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1536-7 (Aug., 1957).

The effect of temperature is investigated on the absorption of infrared radiation of wavelengths between 2 and 3 μ by n-type germanium on injection of current carriers. The absorption so introduced decreased from 23% at a temperature of 293°K to zero at a temperature of 100°K.

535.343

197. BAND SPECTRA IN HOMOGENEOUS ELECTRIC FIELDS.
W.Steubing and J.Hengevoss.
Z. Phys., Vol. 151, No. 1, 20-34 (1958). In German.

Observations carried out in the wavelength range 2000 to 5000 A revealed no effects in OH, NH, CO, CO_2 and CO_2^+ in fields of up to 90 kV/cm. The intensity distribution of nitrogen was altered in the visible wavelengths range and in particular an effect of the perturbed P_{40} and R_{38} lines of N_2^+ 3914 bands was observed.
C.G.Morgan

535.343

198. CHANGES IN THE NEAR ULTRAVIOLET SPECTRUM OF CRYSTALLINE HEXAMETHYLBENZENE ACCOMPANYING A LOW TEMPERATURE PHASE TRANSITION. O.Schnepp.
J. chem. Phys., Vol. 29, No. 1, 56-61 (July, 1958).

The hexamethylbenzene crystal undergoes a phase transition at 110°K. The near ultraviolet absorption spectra of single oriented crystals of this substance were studied in polarized light in the neighbourhood of the transition temperature. A drastic and discontinuous change of the spectra is observed to accompany the phase change. The spectral change at the transition point is interpreted as indicative of a distortion of the molecule such that only twofold axes remain.

535.343

199. ON THE ORIGIN OF THE ABSORPTION BAND IN THE VISIBLE SPECTRUM OF THE VO++ ION. C.Furlani.
Ricerca sci., Vol. 27, No. 4, 1141-5 (April, 1957). In Italian.

The 760 mμ band in the absorption spectrum of the VO++ ion is due to the transition of the odd electron 3d of this ion from one state into another, corresponding to the irreducible representation E_1 and E_2 of the group $C_{\infty}v$, according to which the electrostatic perturbation caused by the electrons of the V—O bond is transformed. The groups coordinated in the second sphere can produce a further splitting into two sub-levels of the excited term.

535.343

200. PRESSURE-INDUCED INFRARED ABSORPTION OF HYDROGEN AND HYDROGEN—FOREIGN GAS MIXTURES IN THE RANGE 1500-5000 ATMOSPHERES. W.F.J.Hare and H.L.Welsh.
Canad. J. Phys., Vol. 36, No. 1, 88-103 (Jan., 1958).

The pressure-induced infrared absorption of hydrogen was studied in pure hydrogen and in hydrogen—helium, hydrogen—argon, and hydrogen—nitrogen mixtures at pressures up to 5000 atm at room temperature. The integrated absorption coefficient can be expressed in the form $\alpha_1\rho_a\rho_p + \alpha_2\rho_a\rho_p^2$ over the whole range of densities (ρ_a = density of H_2, ρ_p = density of the perturbing gas, $\rho_a \ll \rho_p$ in the mixture experiments). The coefficient α_2 is much smaller than predicted from the effect of finite molecular volumes; this is interpreted as a partial cancellation of the induced moments in ternary collisions. The splitting of the Q branch of the fundamental, which is due to the participation of the relative kinetic energies of the colliding molecules in the absorption process, increases linearly with the density because of ternary collisions; a more rapid increase observed at very high densities is not yet explained. The components of the overtone and double vibrational transition, like the Q_Q and S components of the fundamental, show no splitting or broadening with increasing density; these absorptions are believed to be due to quadrupole interactions, while the Q_P and Q_R components of the fundamental are due to overlap interactions.

535.343

201. SOME INFRARED BANDS OF DEUTERIUM SULFIDE.
H.C.Allen, Jr, E.K.Plyler and L.R.Blaine.
J. Res. Nat. Bur. Stand., Vol. 59, No. 3, 211-14 (Sept., 1957).

Two regions of the D_2S spectrum were observed, 5 and 3.6μ. An analysis of the absorption in the 3.6μ region attributes it to two overlapping bands with excited states $(v_1,v_2,v_3) = (1,1,0)$ and $(0,1,1)$. The band centre of the $(0,1,1)$ band is found to be some 50 cm^{-1} lower than the previously accepted value while the $(1,1,0)$ band centre is found some 60 cm^{-1} higher than the previous determination. The absorption near 5μ seems to arise from the $(0,0,1)$ band centred near 1906 cm^{-1}. Overlapping atmospheric absorption makes a detailed analysis impossible at this time. This band centre is almost 100 cm^{-1} lower than previously reported. The excited state constants for the two bands near 3.6μ are

$(1,1,0)$ $\nu_0 = 2742.77$ $A^* = 5.478$ $B^* = 4.512$ $C^* = 2.395$
$(0,1,1)$ $\nu_0 = 2754.44$ $A^* = 5.531$ $B^* = 4.521$ $C^* = 2.405$

535.343

202. INFRARED ABSORPTION SPECTRA OF SOME PYRIDINE MOLECULAR COMPLEXES. L.P.Bicelli.
Nuovo Cimento, Vol. 9, No. 1, 184-5 (July 1, 1958).

535.343 : 539.19

203. MICROWAVE STUDIES OF THE STRUCTURE OF CYCLOPROPYL DERIVATIVES. J.P.Friend and B.P.Dailey.
J. chem. Phys., Vol. 29, No. 3, 577-82 (Sept., 1958).

The microwave spectra of cyclopropyl chloride and cyclopropyl cyanide were studied and rotational constants for the Cl^{35} and Cl^{37} molecules of the chloride and for the normal molecule and two deuterated species of the cyanide were determined. The two deuterated species are the cis and trans forms of

$$\overline{CH_2-CHD-CH}-CN.$$

For $C_3H_5Cl^{35}$, A = 16 625 ± 145 Mc/s, B = 3905.4 ± 0.3 Mc/s and C = 3622.5 ± 0.3 Mc/s. For $C_3H_5Cl^{37}$, A = 16085 ± 415 Mc/s, B = 3810.4 ± 0.5 Mc/s and C = 3540.8 ± 0.5 Mc/s. The following structure fits the rotational constants within the experimental errors: dC–C = 1.5131 A, dC–Cl = 1.7780 A, dC–H = 1.105 A, ∢HCH = = 114° 36', ∢HCCl = 120° 52.9'. For C_3H_5CN, A = 15 917 Mc/s, B = 3465.06 Mc/s, and C = 3286.22 Mc/s. For cis C_3H_4DCN, A = 14 543 Mc/s, B = 3419.34 Mc/s and C = 3229.15 Mc/s. For trans C_3H_4DCN, A = 15 367 Mc/s, B = 3358.79 Mc/s, and C = 3161.26 Mc/s. The following structure fits the rotational constants B and C to an average of 1.5 Mc/s: $dC-C_{(ring)}$ = 1.5131 A, $dC-C_{(CN)}$ = 1.4679 A, dC–H = 1.112 A, dC≡N = 1.1574 A, ∢H–C–H = 115° 35', and

$$\sphericalangle\, C_{(CN)}-C-H = 119° 35'.$$

Analysis of the quadrupole structure in C_3H_5Cl shows that eqQ along the C–Cl bond axis is −71.7 Mc/s for Cl^{35}, indicating 23% ionic character. The asymmetry η = 0.156 for Cl^{35} indicates a double bond character of 4%.

535.343

204. MICROWAVE SPECTRUM OF HYDRAZINE.
T.Kojima, H.Hirakawa and T.Oka.
J. Phys. Soc. Japan, Vol. 13, No. 3, 321 (March, 1958).

535.343.9 : 535.375.5

205. RAMAN SPECTRA OF ALKALI HALIDES.
R.S.Krishnan and P.S.Narayanan.
J. Indian Inst. Sci. A, Vol. 39, No. 2, 85-92 (April, 1957).

The Raman spectrum of potassium iodide was recorded using the 2536 A excitation. The results are compared with the spectra of sodium chloride, potassium bromide and caesium bromide. The details of the spectra of these four halides are critically examined in the light of the existing theories of crystal dynamics.

535.345 : 537.564

206. ABSORPTION AND PHOTOIONIZATION COEFFICIENTS OF FURAN VAPOR. K.Watanabe and T.Nakayama.
J. chem. Phys., Vol. 29, No. 1, 48-51 (July, 1958).

Total absorption coefficients of furan vapour were determined in the region from 1050 to 2150 A by a photoelectric method, and photoionization coefficients in the region from 1050 to 1400 A with an ion chamber. A reassignment of the absorption bands in the region 1400 to 1700 A yielded two Rydberg series converging to 8.89 eV in agreement with the ionization potential obtained by photoionization measurements. Another Rydberg series was found to converge to 9.95 eV corresponding probably to the removal of an inner π electron of furan.

535.345 : 548.5

207. EFFECT OF ALUMINUM AND GERMANIUM ON THE SPECTRAL ABSORPTION OF CERTAIN TYPES OF QUARTZ GROWTH. F.Augustine and D.R.Hale.
J. chem. Phys., Vol. 29, No. 3, 685-6 (Sept., 1958).

Such crystals grown on different crystal faces develop different absorption bands in the ultraviolet after X-irradiation.

G.F.Lothian

535.345 : 535.337 : 537.311.33

208. OPTICAL PROPERTIES OF SEMICONDUCTORS UNDER HYDROSTATIC PRESSURE. I. GERMANIUM.
W.Paul and D.M.Warschauer.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 89-101 (1958).

The room-temperature absorption spectrum of high-purity single-crystal germanium was measured between absorption coefficients of 1 and 100 at hydrostatic pressures up to 7000 kg/cm^2. The results were interpreted to give a pressure coefficient for the optical energy gap in satisfactory agreement with the more precise value determined from measurement of the intrinsic resistivity as a function of pressure.

535.345 : 535.337 : 537.311.33

209. OPTICAL PROPERTIES OF SEMICONDUCTORS UNDER HYDROSTATIC PRESSURE. II. SILICON.
W.Paul and D.M.Warschauer.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 102-6 (1958).

The pressure coefficient of the optical absorption edge due to indirect transitions was measured in silicon over a pressure range of 1-8000 kg/cm^2. A value of $(dE/dP)_T = -1.3 \times 10^{-12}$ eV/dyne cm^{-2} was obtained, in agreement with other optical and resistivity measurements. The lack of an observable change of shape of the edge with pressure implies that a simple displacement of the (100) conduction-band minima relative to the (000) valence-band maximum takes place with change of pressure.

535.345

210. LOW-LEVEL ABSORPTION IN GERMANIUM.
T.S.Moss and T.D.H.Hawkins.
Phys. Rev. Letters, Vol. 1, No. 4, 129-30 (Aug. 15, 1958).

Absorption coefficients as low as 10^{-5} cm^{-1} were measured by focusing radiation on an end face of a Ge filament 4 cm long, and measuring the photoconductivity between electrodes over 3 cm apart. Two parts of the absorption curve correspond to energy thresholds of 0.576 and 0.560 eV. C.Hilsum

535.371

211. ON THE FLUORESCENCE YIELD OF ORGANOPHOSPHORS. D.Frąckowiak.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 10, 991-5 (1957).

The dependence of the fluorescence yield in rigid solutions of fluorescein in glucose on the excitation wavelength has been measured for various dye concentrations and various temperatures of ebullition of the solutions. The shape of the yield curves and of the absorption and fluorescence spectra depends markedly on the manner of preparation of the solutions, and the effects are attributed to the formation of dimers and dye-glucose molecular complexes.

J.B.Birks

535.371

212. DELAYED FLUORESCENCE IN NAPHTHALENE CRYSTALS AT 4°K. H.Sponer, Y.Kanda and L.A.Blackwell.
J. chem. Phys., Vol. 29, No. 4, 721 (Oct., 1958).

The fluorescence of naphthalene crystals was observed through a phosphoroscope indicating that a part of this emission has a lifetime greater than 10^{-3} sec at 4.2°K. It is suggested that this phenomenon is connected with the photoconductivity observed in crystals of aromatic compounds and has its origin in the storage of energy by an electron trapping mechanism.

535.373 : 535.23.08

213. INVESTIGATIONS ON THE QUANTUM YIELDS OF FLUORESCENT MATERIALS WITH REFERENCE TO THEIR USE FOR RADIATION MEASUREMENTS IN THE ULTRAVIOLET. J.F.Hammann.
Z. angew. Phys., Vol. 10, No. 4, 187-92 (April, 1958). In German.

The relative efficiencies (η) of conversion of various wavelengths into fluorescent radiation are determined for: a film of sodium salicylate, where η is constant between 2300 and 3400 A, decreasing at longer wavelengths; films of anthracene, where η is constant over the whole measured range (2300-3700 A); a solution of anthracene, where η is constant from the shortest measured wavelength (3100 A) to 5100 A. Filters used to give short-wave cut-off in the measurements are listed. G.F.Lothian

535.376

214. ON THE FLUORESCENCE OF AIR, EXCITED BY FAST ELECTRONS: LIGHT YIELD AS A FUNCTION OF PRESSURE. A.E.Grün.
Canad. J. Phys., Vol. 36, No. 7, 858-62 (July, 1958).

The fluorescence was excited by electrons of 4.2 to 43.7 keV and the light intensity I_f was measured by a 1 P28 photomultiplier tube. The energy W transferred from the electrons to the gas molecules in a defined space could be accurately measured. The light yield, as defined by $\Phi = I_f/W$, was experimentally determined as a function of the gas density ρ, or pressure p, respectively. The result is: $1/\Phi + p/p'$, with p' = 11.5 mm Hg.

535.376

215. ELECTRON EXCITATION OF BILAYER SCREENS.
L.R.Koller and H.D.Coghill.
J. appl. Phys., Vol. 29, No. 7, 1064-6 (July, 1958).

The control of the colour of the luminescence of thin transparent superimposed phosphor films when excited by electron beams of varying voltage is discussed. The quantitative relations are found to be in agreement with a theory based on the laws of electron penetration and scattering.

535.376 : 537.226.2

216. DIELECTRICAL PROPERTIES OF ELECTROLUMINESCENT AND PHOSPHORESCENT ZINC SULPHIDES AND ASSUMPTIONS ON MECHANISM OF ELECTROLUMINESCENCE.
A.Luyckx, J.Vandewauwer and S.Ries.
Ann. Soc. Sci. Bruxelles I, Vol. 72, No. 1-2, 58-74 (1958).

The loss angle in electroluminescent cells increases, the equivalent resistance decreases, and the capacitance increases slightly as the applied a.c. voltage increases at 50 c/sec. Phosphorescent but non-electroluminescent powders do not show these changes. The importance of internal processes and of cathode potential barriers are discussed in regard to the variations of $\tan\delta$. S.T.Henderson

535.376

217. ELECTROLUMINESCENCE OF ZINC SULFIDE PHOSPHORS AS AN EQUILIBRIUM PROCESS. W.Lehmann.
J. Opt. Soc. Amer., Vol. 48, No. 9, 647-53 (Sept., 1958).

The intensity of the time-average output of the steady-state electroluminescence of powdered zinc sulphide phosphors in an intense alternating electric field is characterized by a dynamic equilibrium between the monomolecular collision excitation process and the bimolecular recombination process. This equilibrium condition permits predictions of the dependence of the emission intensity, the efficiency, and other properties on several parameters such as the voltage, the temperature, and the concentrations of electron traps and activator centres. These predictions are compared with experimental results.

535.39

218. INFRA-RED TRANSMISSION LIMITS AND REFLECTIVITY OF LITHIUM-6 FLUORIDE AND LITHIUM-7 FLUORIDE.
R.W.H.Stevenson and P.T.Nettley.
Nature (London), Vol. 182, 471-2 (Aug. 16, 1958).

Reflection measurements give peaks at 630 (Li^6F) and 600 cm^{-1} (Li^7F), whose ratio accords with theory. Curves of transmission measurements are also given. G.F.Lothian

535.391

219. REFLECTION COEFFICIENT OF OPTICALLY INHOMOGENEOUS LAYERS. J.F.Hall, Jr.
J. Opt. Soc. Amer., Vol. 48, No. 9, 654-7 (Sept., 1958).

The reflection coefficient is calculated for radiation incident normally on a nonabsorbing, optically inhomogeneous, plane parallel layer bounded on either side by nonabsorbing semi-infinite media. The theory is applied to determine the reflectance of a layer in which the index of refraction varies nearly linearly with the thickness.

535.393

220. HEAT-REFLECTING WINDOWS USING GOLD AND BISMUTH OXIDE FILMS. L.Holland and G.Siddall.
Brit. J. appl. Phys., Vol. 9, No. 9, 359-61 (Sept., 1958).

The observation window of an enclosure exposed to infrared radiation was coated with different film combinations, and their effectiveness in reducing the internal temperature rise determined. The reflectance and transmittance of the coatings were measured at 0.56 μ and in the infrared region using a photometer with a broad bandwidth (0.8-2 μ). Results are given for the following: plain glass; a high reflecting bismuth oxide film on glass; gold film on glass; and gold films sandwiched between bismuth oxide and silicon monoxide coatings. Optimum performance was obtained with a $Bi_2O_3/Au/Bi_2O_3$ multi-layer of 450/130/450 A thickness, which had a transmittance of 73% for green light and a reflectance of 74% in the near infrared region, compared with values of 55 and 35% respectively for a gold film of the same thickness without the oxide layers.

535.393

221. THE OPTICAL PROPERTIES OF CHROMIUM.
R.M.Hill and C.Weaver.
Trans Faraday Soc., Vol. 54, Pt 8, 1140-6 (Aug., 1958).

An investigation into the optical properties of chromium is described, using the polarimetric technique. The results obtained show disagreement with the previously published values. It is suggested that this may be due to the presence of a polish, or oxide, layer on the specimens' surfaces. The refractive index of bulk chromium was measured as 1.18-i1.06 for light of wavelength 5461 A. The surface film on a polished bulk metal specimen was found to have a refractive index of 2.42, and a thickness of 50 A. A thick evaporated specimen of the same metal was found to give similar metallic values, and to sustain a surface film of the same thickness but of refractive index 2.23.

535.399

222. ANTIREFLECTION COATINGS FOR GERMANIUM AND SILICON IN THE INFRARED. J.T.Cox and G.Hass.
J. Opt. Soc. Amer., Vol. 48, No. 10, 677-80 (Oct., 1958).

Very hard and durable single layer antireflection coatings for Ge and Si were made which result in a peak transmittance of better than 98% at any desired wavelength in the infrared up to about 15 μ. Silicon monoxide makes an excellent antireflection coating for silicon and germanium in the near infrared, but cannot be used in the 10 μ region where is becomes strongly absorbing. Zinc sulphide has been found to be the most suitable antireflecting material at the longer wavelengths. Under proper conditions zinc sulphide films, which in the past have frequently exhibited unsatisfactory durability, can be prepared as very hard and adherent antireflection coatings for germanium and silicon. The best zinc sulphide films are obtained when the substrate is heated to about 150° C and cleaned with a d.c. glow discharge just before the evaporation is made. The coatings can stand several hours boiling and several days immersion in water without damage and have been used for periods up to one year without showing any deterioration.

535.417 : 531.715

223. TWO-BEAM HIGH CONTRAST INTERFEROMETRY.
N.Barakat.
Acta phys. Austriaca, Vol. 12, No. 1, 108-11 (1958).

535.417

224. SPECTRAL EFFECTS IN INTERFEROMETRY.
G.D.Kahl and D.B.Sleator.
J. Opt. Soc. Amer., Vol. 48, No. 8, 525-30 (Aug., 1958).

The influence on the fringe intensities of sources with known spectral energy density functions is analysed both theoretically and experimentally for double beam interferometers of the Mach–Zehnder type. Simple relations between the spectrum and the fringe intensity and extent of the fringe field are presented. Special attention is given energy sources consisting of a primary source used with a monochromator. Experimental confirmation is demonstrated.

535.417 : 534.152

STROBOSCOPIC INTERFEROMETER FOR VIBRATION MEASUREMENT. See Abstr. 130

SOME CONSIDERATIONS ABOUT THE PRECISION OF THE INTERNATIONAL STANDARD OF WAVELENGTH. See Abstr. 177

535.42

225. AN ASYMPTOTIC EXPANSION OF A DOUBLE INTEGRAL OCCURRING IN DIFFRACTION THEORY. N.Chako.
C.R. Acad. Sci. (Paris), Vol. 247, No. 4, 436-8 (July 28, 1958). In French.

An application of the method of stationary phase to integrals of the form

$$\iint_D g(x,y)\exp ik\phi(x,y)\,dxdy$$

where $k\phi$ is such that the exponential oscillates rapidly over most of D. A series in descending, possibly non-integer, powers of k is obtained. W.T.Welford

535.42

226. APPLICATION OF THE METHOD OF STATIONARY PHASE IN THE THEORY OF THE DIFFRACTION OF OPTICAL IMAGES. N.Chako.
C.R. Acad. Sci. (Paris), Vol. 247, No. 5, 580-2 (Aug. 4, 1958). In French.

Explicit asymptotic expressions are derived for the image functions due to certain point types which appear in the diffraction theory of optical instruments. S.Tolansky

535.42 : 548.574 : 539.27

227. LIGHT DIFFRACTING STRIATIONS IN SILICON. R.L.Hopkins.
J. appl. Phys., Vol. 29, No. 9, 1378-9 (Sept., 1958).

The coloured parallel lines which appear when single crystal silicon is etched were examined by both an optical and an electron microscope. Each line is made up of several lamellae from 200 to 10 000 A wide. The orientation of the lamellae relative to the crystal axes was measured. C.Hilsum

535.42 : 534.321.9

228. MULTIPLE DIFFRACTION OF LIGHT BY ULTRASONIC VIBRATIONS IN TRANSPARENT SOLIDS. J.M.Barnes, W.G.Mayer and E.A.Hiedemann.
J. Opt. Soc. Amer., Vol. 48, No. 9, 663-5 (Sept., 1958).

Ultrasonic waves in transparent solids are used to produce multiple light diffraction patterns. It is shown that the form of the patterns depends on the vibrational resonance conditions of the samples. The influence of longitudinal and shear elastic waves on the production of secondary and tertiary diffraction patterns is discussed. The presence of a visible secondary shear diffraction order is demonstrated in sapphire.

535.42 : 534.512.1

229. ON THE "METHOD OF PARTS" FOR THE DIFFRACTION OF LIGHT BY SUPERPOSED AND STANDING SUPERSONIC WAVES. R.Mertens.
Simon Stevin, Vol. 32, No. 2, 80-90 (June, 1958).

The problem of the diffraction of light in a liquid through which ultrasonic waves are travelling, in opposite directions and at different frequencies, is considered. A new hypothesis is used and yields a more rigorous treatment than previous theories. It is shown that the system of difference-differential equations may be used to give the diffraction pattern in the case of standing waves. R.W.Fish

535.551

230. TEMPERATURE DEPENDENCE OF PHOTO-ELASTIC CONSTANTS IN ALKALI HALIDES. S.Bhagavantam and Y.Krishna Murty.
Proc. Indian Acad. Sci. A, Vol. 46, No. 6, 399-405 (Dec., 1957).

Measurements are presented of the birefringence produced at different temperatures in crystals of NaCl, KCl and KBr when subjected to stress. The results show that the stress-optical coefficients $(q_{11} - q_{12})$ and q_{44} decrease in the case of NaCl almost linearly with temperature, while in KCl and KBr they increase. The variation for rock salt is of the order of about 30% over an interval of 300 deg C. In both KCl and KBr, the variation in $(q_{11} - q_{12})$, which is about 40% over the same interval of temperature, is much greater than in q_{44}, which is of the order of about 15%. The corresponding strain-optical coefficients are also evaluated and given at each temperature.

535.56 : 538.61

231. MAGNETO-OPTIC CONSTANTS OF IONS IN AQUEOUS SOLUTIONS. V.Sivaramakrishnan.
J. Indian Inst. Sci. A, Vol. 139, No. 2, 108-12 (April, 1957).

The rotation for 5461 A and the optical dispersion were measured for some acids and their salts at various concentrations. From these data the specific Verdet constant, the molecular magnetic rotation, optical dispersivity and the magneto-optic anomaly factor were estimated. It is found that all these constants vary considerably with concentration, thereby revealing that the intrinsic magneto-optic polarizability of the ions varies with concentration. The values extrapolated to infinite dilution were also determined, and from these the specific Verdet constant and the magnetic rotation of the different anions and cations found.

535.642.2 : 535.651

232. RELATIVE SPECTRAL ENERGY DISTRIBUTION OF STANDARD LIGHT SOURCES FOR COLORIMETRY. B.Hisdal.
J. Opt. Soc. Amer., Vol. 48, No. 9, 608-13 (Sept., 1958).

Because of the variation in emissivity of tungsten within the visible spectrum, the relative spectral energy distribution of a tungsten ribbon filament lamp calibrated as C.I.E. source A will deviate from the Planckian distribution adopted and tabulated by the C.I.E. for this source. Likewise, the energy distributions of standard sources B and C, when used with a calibrated tungsten ribbon filament lamp, will deviate from those generally given. It is shown that this deviation can introduce a change in chromaticity coordinates which is bigger than the smallest chromaticity differences distinguishable in a large field of view under good observing conditions. Reasons are given for believing that the relative energy distribution values of a source A lamp with coiled filament will be nearer to the tabulated data. The actual relative energy distribution of a properly calibrated source A lamp may therefore vary somewhat according to the type of filament used in the lamp. Two ways of defining the standard source A lamp and its energy distribution so as to reduce this uncertainty are suggested.

535.65

233. DESCRIPTION AND MEASUREMENT OF WHITE SURFACES. R.S.Hunter.
J. Opt. Soc. Amer., Vol. 48, No. 9, 597-605 (Sept., 1958).

This is the report of Inter-Society Colour Council Subcommittee on Problem 19 formed in 1953 to study the colour technology of white surfaces. Physically, surfaces which appear white reflect strongly and diffusely throughout the visible spectrum. Psychophysically, whites occupy a volume without sharply defined boundaries in the top centre of the colour solid. Whiteness is the attribute of white surfaces which corresponds to their visual proximity to preferred white. Preferred white varies somewhat with changes of either observer or observing situation. Measurements and intercomparisons of the colours of whites are made to determine adequacies of match to standard and to determine compliance with colour specifications. One-number reflectance measurements of whites are widely used as partial determinations of whiteness. There have been a number of investigations to find which formulae yield the most reliable measurements of whiteness from tristimulus values, but the whiteness scales which have resulted from these investigations have not enjoyed widespread commercial use.

535.65

234. COMPARISON OF MUNSELL AND MACADAM COLOR SPACES. H.R.Davidson and H.Hemmendinger.
J. Opt. Soc. Amer., Vol. 48, No. 9, 606-8 (Sept., 1958).

Because of the growing interest in uniform chromaticity scales, a comparison between the Munsell colour space and a colour space based on MacAdam's visual sensitivity data is of importance. In order to make this comparison the C.I.E. coordinates are established for a Munsell type cylindrical space sampling conforming to MacAdam's data. In the colour space so formed, a colour difference of one chroma step, for example, will be the same in any region when that difference is calculated from MacAdam's data. This "MacAdam space" differs materially from Munsell renotation space. The distance of the constant chroma loci from neutral in the purple-blue region is approximately doubled, and the constant hue loci are shifted as much as 10 hue steps in the green and red region.

535.7

PHYSIOLOGICAL OPTICS. VISION. See also the Section entitled "BIOPHYSICS. PHYSIOLOGICAL PHYSICS".

535.81

235. INTERSTITIAL GRATICULES. A.J.C.Hall and J.G.Hayes.
Austral. J. appl. Sci., Vol. 9, No. 3, 207-15 (Sept., 1958).

A new type of graticule is described. The pattern is formed beneath the surface of glass by introducing ions from a surface pattern of silver, or copper, into interstices in the glass structure and then reducing these to a visible form. Two simple methods of doing this are given, a gaseous one using low concentrations of sulphur trioxide and an electrolytic one. Reaction temperatures are generally between 250° and 450°C. Patterns of fine or coarse lines or dots that are superior to existing types in durability can be produced; these may be coloured and transparent, or opaque. The process is suitable for mass production of graticules, and has other applications such as the permanent marking of chemical or medical glassware and the reproduction of line drawings or half-tone photo-

535.81 : 681.4

236. BONDING OPTICAL COMPONENTS TO METAL MOUNTS. K.H.Spring.
Brit. J. appl. Phys., Vol. 9, No. 6, 242-6 (June, 1958).

Various methods of bonding optical components to metal mounts, using synthetic resin adhesives, are described. In some cases a rubber interlayer is necessary to maintain resilience and prevent strain in the glass. A sandwich-type silicone rubber interlayer may be used to maintain resilience at temperature extremes. The tensile strength and shock resistance of the various types of bond are discussed, and a laboratory shock-tester suitable for small specimens is described.

535.81

237. FAR INFRARED TRANSMISSION THROUGH METAL LIGHT PIPES. R.C.Ohlmann, P.L.Richards and M.Tinkham.
J. Opt. Soc. Amer., Vol. 48, No. 8, 531-3 (Aug., 1958).

The fractional transmission of far infrared radiation through metal light pipes is calculated and compared with experimental data. Transmission factors greater than fifty percent are obtained over distances of several feet with typical parameters. Condensing cones allow the output radiation to be concentrated on to a small detector area for spectroscopic applications.

535.824.1

238. A TRIPLET EYEPIECE. II. GAUSSIAN THEORY. A.Biot.
Ann. Soc. Sci. Bruxelles I, Vol. 72, No. 1-2, 39-48 (1958).
In French.

A new type of triplet eyepiece has been previously described, (Abstr. 7885/1955). This second part gives the Gaussian theory for the general triplet eyepiece and derives the condition for achromatism when the eye is focused at infinity. The condition is shown to reduce to the more usual condition for a Huyghenian eyepiece.

R.W.Fish

535.824.1

239. A TRIPLET EYEPIECE. III. GENERAL CONDITION OF ACHROMATISM. A.Biot.
Ann. Soc. Sci. Bruxelles I, Vol. 72, No. 1-2, 49-56 (1958).
In French.

Derives the general condition for achromatism when the image formed is not at infinity, for example in projection eyepieces. The formulae are applied to a Huyghenian eyepiece as well as the triplet.

R.W.Fish

535.831 : 535.24

240. PHOTOMETRY OF TELESCOPES AND BINOCULARS.
Notes appl. Sci. Nat. Phys. Lab., No. 14, 18 pp. (1955).

The measurement of light transmission, veiling glare and field brightness are dealt with.

535.89

241. TRANSPARENT FERROMAGNETIC LIGHT MODULATOR USING YTTRIUM IRON GARNET.
C.S.Porter, E.G.Spencer and R.C.LeCraw.
J. appl. Phys., Vol. 29, No. 3, 495-6 (March, 1958).

A method of preparation of yttrium iron garnet crystals from Y_2O_3 and Fe_2O_3, using PbO as a solvent, is described. The transmission spectrum from 0.5 to 16 μ of ground and polished slabs cut from the crystals shows strong absorption at wavelengths shorter than 0.7 μ; other absorption occur at 0.89, 5.7, 7.8, 8.6, 10.9, 11.6 and 14 μ. Faraday rotation brought about by spontaneous magnetization normal to the slab can be applied to the design of light modulators. Three of these are described and the construction and operation of one is discussed. It is an axially a.c. magnetized slab, passing polarized tungsten light to an analyser 45° out of the plane of polarization.

HEAT

536.2 : 532.517.4

242. HEAT TRANSFER IN TURBULENT TUBE FLOW.
H.L.Beckers.
Appl. sci. Res. A, Vol. 6, No. 2-3, 147-90 (1956).

The differential equation for the temperature distribution in turbulent flow through a smooth cylindrical tube is

$$\frac{1}{r}\frac{\partial}{\partial r}\left[(A + A_q)\frac{r\partial T}{\partial r}\right] = u\frac{\partial T}{\partial z},$$

where the thermal diffusivity A is increased by the thermal eddy diffusivity A_q due to turbulent mixing, and A_q depends upon the velocity distribution. The cross-section of the tube can be divided into three concentric regions: the turbulent core, the laminar boundary layer and the transition layer. The general solution of the differential equation valid for each of the regions is obtained. The constants are so chosen that the temperatures and heat currents are continuous at the boundaries between the regions. For a constant wall temperature the first two eigenfunctions and eigenvalues are calculated for several Re and Pr numbers.

S.Weintroub

536.2.01

243. THE TRANSPORT THEORY OF TEMPERATURE WAVES IN INSULATORS. R.Englman.
Proc. Phys. Soc., Vol. 72, Pt 3, 391-400 (Sept., 1958).

Heating the surface of an insulator by a rapidly fluctuating source results in a temperature distribution in the solid, which is usually described as an attenuated wave. For high frequency fluctuations, when this description may not be valid, the temperature is found as a solution of the Boltzmann equation. Expressions are derived for various related quantities in terms of the phonon source, its frequency and the coefficient of reflection of the phonons at the boundary.

536.2.02 : 533.16 : 533.7

APPROXIMATE FORMULAE FOR THE THERMAL CONDUCTIVITY OF GAS MIXTURES. See Abstr. 119

536.2.083 : 534.222.2

244. DEVELOPMENT OF THE CALORIMETER HEAT TRANSFER GAUGE FOR USE IN SHOCK TUBES. P.H.Rose.
Rev. sci. Instrum., Vol. 29, No. 7, 557-64 (July, 1958).

A gauge suitable for measuring extremely high heat transfer rates under the quasi-transient conditions occurring in shock tubes was developed. The instrument is based on a calorimetric principle and is made possible by the short steady state times inherent in shock tubes. The technique developed extends, verifies, and supplements the shock tube heat transfer measurements made by thin film resistance thermometers. The operating principles and experimental experiences with calorimeter heat transfer gauges are reported in some detail. Heat transfer data obtained with calorimeter gauges are presented. Experimental measurements of laminar and turbulent heat transfer rates at velocities up to satellite speeds, approximately 26 000 ft/sec, are reported. Heat transfer rates as high as 40 kW/cm^2 were encountered in these experiments.

536.212

245. THERMAL TRANSDUCERS. M.Kovarik.
Austral. J. appl. Sci., Vol. 9, No. 3, 225-35 (Sept., 1958).

A new type of transducer is described, using heat propagation in homogeneous solid bodies as the means of transmission of signals. A general theory of the transducer is developed and a fundamental relation for its transfer function derived. Analysis or synthesis of the transfer function is possible on the basis of this relation. The analytical method is demonstrated in two examples, leading to design equations for a thermal integrator and a thermal differentiator. Application of the thermal integrator to an automatic control system is described and experimental results are included.

536.212.3

246. THE FLOW OF HEAT IN A PARALLEL-FACED INFINITE SOLID. T.P.Newcomb.
Brit. J. appl. Phys., Vol. 9, No. 9, 370-2 (Sept., 1958).

A solution is given for the problem of heat conduction in an infinite slab in which one face is subjected to a linearly decreasing thermal flux Q(1 − at), there being no flow of heat at the parallel boundary. This solution may be applied to the problem of braking with uniform deceleration. Typical curves illustrating the agreement between transient temperatures determined theoretically and experimentally at different points in the slab are given.

536.212.3

247. HIGH-TEMPERATURE HEAT CONDUCTIVITY OF SOME METAL OXIDES. J.C.Jamieson and A.W.Lawson.
J. appl. Phys., Vol. 29, No. 9, 1313-14 (Sept., 1958).

A re-analysis of data on the thermal conductivity of certain metal oxides (e.g. MgO, Al_2O_3, BeO) has shown that the deviation from a T^{-1} law may be fitted to a law exponential in T^{-1}. Thus the deviations may be ascribed to the flow of excitons. The contribution to the thermal conductivity from radiative transfer is shown to be too small to fit the observed deviations.

536.212.3 : 536.48

248. THERMAL CONDUCTIVITY OF THE SOLIDIFIED INERT GASES: ARGON, NEON AND KRYPTON. G.K.White and S.B.Woods.
Phil. Mag. (Eighth Ser.), Vol. 3, 785-97 (Aug., 1958).

The thermal conductivity of the solidified inert gases A, Ne and Kr, contained in an Inconel tube, was measured at temperatures from 2°K to near their melting points. Above about 15°K, it is found that the thermal conductivity, λ, may be represented by the expression $\lambda \cong B/T$, where B has values of 250 mW cm^{-1} for A, 75 for Ne, and 270 for Kr. Values calculated from approximate

theoretical treatments of lattice anharmonicity yield values in excess of these by about 30% to 80%. At liquid-helium temperatures, i.e. below the conductivity maximum, it is found that λ varies approximately as T^3 and is small in magnitude, suggesting mean free paths of 10^{-5} to 10^{-4} cm for the lattice waves. This may result from the large contraction of the solids during cooling which produces severe internal strains and probably results in many lattice defects within the crystals.

536.22 : 536.23

249. REDUCED THERMAL CONDUCTIVITY CORRELATION. GASEOUS AND LIQUID HYDROGEN. C.A.Schaefer and G.Thodos.
Industr. engng. Chem., Vol. 50, No. 10, 1585-8 (Oct., 1958).

Information is presented about the thermal conductivity of gaseous and liquid hydrogen at high pressures and over extensive ranges of temperature.

536.25

250. MODIFIED CORRELATION FORMULAE FOR THE HEAT TRANSFERS BY NATURAL AND BY FORCED CONVECTION FROM HORIZONTAL CYLINDERS. B.G. van der Hegge Zijnen.
Appl. sci. Res. A, Vol. 6, No. 2-3, 129-40 (1956).

Heat transfer by natural and by forced convection from horizontal cylinders to fluids is reviewed. Experimental data of various origins are assembled, and modified correlation formulae are derived from them; they have a wider range of applicability than those used hitherto. A new correlation formula is presented for the heat transfer from cylinders to air by combined natural and forced horizontal convection; it serves for predicting the magnitude of the Reynolds' number above which natural convection is negligible.

536.33.08 : 535.23.08

251. MODERN BOLOMETERS. I.D.Konosenko.
Zh. tekh. Fiz., Vol. 20, No. 6, 645-65 (1950). In Russian. German translation in: Exper. Tech. der Phys., Vol. 2, No. 3, 130-44 (1954).

A review article giving the basic operating principles of different types of bolometer and the electrical circuits with which they are used. Tables of the main properties of bolometer materials are given, together with performance figures of many experimental bolometers quoted in the literature. 58 references. R.W.Fish

536.33.08

252. OBSERVABILITY OF SPONTANEOUS TEMPERATURE FLUCTUATIONS. T.P.Gill.
Nature (London), Vol. 182, 239-40 (July 26, 1958).

The effects of thermal, Johnson, and current noise on measurements on bolometers are discussed. Adding the expected noise powers to obtain an estimate of the total noise power can lead to definitely incorrect results, although it is predicted that Johnson noise will generally mask thermal noise. Measurements on an evaporated gold bolometer gave no indication of thermal noise, though this was perhaps due to the limitations of the equipment used. P.Gray

536.33.08 : 536.53

253. RESEARCHES ON THE ESTABLISHMENT OF STANDARDS FOR MEASURING THERMAL RADIATION. H.Satone.
Researches Electrotech. Lab. (Tokyo), No. 565, 81 pp. (Feb., 1958). In Japanese. Summary (3 pp.) in English.

A detailed description is given of the construction of a standard blackbody furnace, of 1 m overall length and with a blackbody section 52 cm long and 10 cm diameter. The temperature distribution is uniform to within ±2 deg C at 1000°C over a length of 28 cm and the deviation from the perfect blackbody is kept within 0.1%. The characteristics of various types of thermocouple were investigated and the results compared. The sensitivity ($mV\,W^{-1}\,cm^{-2}$) of the Kipp-111 thermopile coated with platinum-black was independent of the temperature T of the blackbody, but the sensitivity of other thermopiles coated with camphor-black or with mica or quartz windows varied as 1/T. The absorption by H_2O and CO_2 in the air through which the total radiation passed was studied. A constant temperature and low humidity box was constructed to exclude the vapour from the air and in consequence the sensitivity was in accordance with the relation

$$(R^2 + d^2)(e_b - e_s)/(1 - A_T)R^2\sigma\epsilon_b(T^4 - T_0^4),$$

where e_b and e_s are the e.m.f.'s of the thermopile when the water-cooled shutter is open and closed respectively; R the standard aperture radius; A_T the absorption factor; d the distance from the standard aperture to the receiving surface; σ the Stefan–Boltzmann constant; ϵ_b the emissivity of the blackbody furnace; and T_0 the temperature of the surface of the water-cooled shutter. S.Weintroub

536.413.2 : 539.2

254. THERMAL EXPANSION OF SODIUM AND POTASSIUM CHLORIDES FROM LIQUID-AIR TEMPERATURES TO +300°C. R.Srinivasan.
J. Indian Inst. Sci. A, Vol. 37, No. 4, 232-41 (Oct., 1955).

The thermal expansion coefficients of sodium and potassium chloride were measured from liquid-air temperatures to +300°C. The expansion coefficients of iron pyrites from liquid-air temperature to 0°C and of rock salt from room temperature to 300°C are also reported. The Gruneisen constants for NaCl and KCl are shown to decrease with temperature. In potassium chloride the decrease is more rapid. A comparison of the lattice expansion coefficients and the macroscopic expansion coefficients of sodium and potassium chlorides is made. The need for an accurate lattice expansion measurement of sodium chloride at high temperatures is emphasized. In potassium chloride a systematic difference exists between the values of the author and the lattice expansion values of Glover (Abstr. 10126/1954). Though the experiments were carried out on different specimens this difference is small and is just on the limit of experimental error. Also it is shown that rock salt and sodium chloride possess identical expansion coefficients within the limits of experimental error.

536.413.2 : 539.2

255. THERMAL EXPANSION OF POTASSIUM BROMIDE FROM LIQUID AIR TEMPERATURE TO 300°C. R.Srinivasan.
J. Indian Inst. Sci. A, Vol. 38, No. 1, 20-2 (Jan., 1956).

The expansion coefficient is found to vary linearly with temperature over the entire range according to the following equation:

$$a_t = (37.62 + 4.1 \times 10^{-2}\, t_c) \times 10^{-6}$$

536.422/.423 : 532.529

256. EVAPORATION INTO A BOUNDARY LAYER.
E.Bauer and M.Zlotnick.
Phys. of Fluids, Vol. 1, No. 4, 355-6 (July-Aug., 1958).

The evaporation rate of a solid or liquid into a stream of gas flowing across its surface is considered as a function of surface temperature and of material and gas properties, neglecting chemical reactions. One of the boundary conditions to be used at the interface between the gas and the solid (or liquid) is derived.

536.422.1 : 537.311.31

257. THE EFFECT OF STRONG ELECTRIC FIELDS ($\sim 10^6$ V/cm) ON THE VOLATILITY AND ELECTRICAL RESISTANCE OF METALS (Mo, Ta, W). N.A.Gorbatyĭ and G.N.Shuppe.
Zh. tekh. Fiz., Vol. 28, No. 3, 623-35 (1958). In Russian.

The apparatus and experimental techniques are described in detail. An account is given of experiments in which the loss of weight by volatilization of thin Mo, Ta and W threads heated up to 2500°K in high vacuum (10^{-8} mm Hg) was measured directly either by weighing (Mo) or by the radioactive-tracer technique (Ta, W). Strong electric fields (2.6×10^6 V/cm) had no effect on the volatility of the investigated metals, and the results of the loss-of-weight measurements were confirmed by the fact that the rate of increase of the electrical resistance of the wire specimens caused by a reduction of their cross-section area due to volatilization was not affected by the application of an electric field. With the aid of the radioactive tracer technique the latent heat of evaporation of Ta and W and the rates of volatilization at various temperature were determined. The resistivities of Mo, Ta and W were not affected by strong electric fields and it is shown that the anomalous, unexplained effects of electric field on resistivity of metals reported by other workers can be attributed to various parasitic currents, particularly the electrostatic emission from the pointed ends of the electrodes. M.H.Sloboda

536.423

258. THE TIME-DEPENDENT DIFFUSION THEORY FOR CONDENSATION ON SPHERICAL AND PLANE SURFACES. J.S.Kirkaldy.
Canad. J. Phys., Vol. 36, No. 4, 446-55 (April, 1958).

The diffusion field and the temperature distribution are calculated for the surroundings of a pure solid or liquid phase at constant temperature growing into an infinitely extended binary fluid phase of different specific volume. The solutions for spherical condensates are applicable to the condensation from air of water vapour on ice or water drops. It is demonstrated that the generally accepted quasi-stationary diffusion theory for spherical drops leads fortuitously to the correct growth law.

536.423.15

259. VAPOUR PRESSURES OF PHENOL AND THE CRESOLS. D.P.Biddiscombe and J.F.Martin.
Trans Faraday Soc., Vol. 54, Pt 9, 1316-22 (Sept., 1958).

The vapour pressures of phenol, o-, m- and p-cresol were measured over the temperature ranges 0-40°C and 110-200°C. The results have been fitted to two-constant equations, $\log_{10} P = A - B/(t + 273)$ for the lower temperature range, and to Antoine equations, $\log_{10} P = A - B/(t + C)$ for the higher range. Values for the normal boiling points, for dt/dP, and for heats of vaporization are given.

536.423.8

260. THE INFLUENCE OF MONOLAYERS ON EVAPORATION FROM WATER STORAGES. I. THE POTENTIAL PERFORMANCE OF MONOLAYERS OF CETYL ALCOHOL. W.W.Mansfield.
Austral. J. appl. Sci., Vol. 9, No. 3, 245-54 (Sept., 1958).

It is estimated that permanent and complete application of a molecular film of cetyl alcohol to the surface of a water storage should reduce annual evaporation losses by 50% or more. The effects of varying atmospheric conditions on the ability of such a film to reduce evaporation are outlined.

536.461

261. EFFECT OF PRESSURE ON ION FORMATION IN PROPANE–AIR FLAMES. I.R.King.
J. chem. Phys., Vol. 29, No. 3, 681-2 (Sept., 1958).

Ion concentrations were measured by a probe method for lean flames between 1.0 and 0.145 atm. The maximum ion mole fraction was nearly constant at 5×10^{-9}, but the maximum extended over a greater distance at low pressure, due to slower recombination.

A.G.Gaydon

536.48 : 539.12

262. ENERGY–MOMENTUM RELATION IN LIQUID HELIUM BY INELASTIC SCATTERING OF NEUTRONS. D.G.Henshaw.
Phys. Rev. Letters, Vol. 1, No. 4, 127-9 (Aug. 15, 1958).

The first part of these measurements is similar and in agreement with Palevsky et al. (Abstr. 2277/1958) and Yarnell et al. (Abstr. 6924/1958). In the second part the wavelength distribution of 4.14 A neutrons scattered through 80° from liquid helium was measured at 1.27°, 1.57°, 2.08° and 4.21°K, using a rotating crystal time-of-flight neutron spectrometer. With increasing liquid temperature the spectrum of the scattered neutrons broadens and the position of the maximum moves to shorter wavelengths. Near and above the λ-point the scattering width is of the order of magnitude calculated from a free particle model but already at 1.57°K the width is much smaller, suggesting a relation between the scattering width and the entropy of the liquid. Preliminary results are given for similar measurements at 21.4 and 3.7 atm. These indicate that at the higher pressure the energy change of the scattered neutrons is lowered by ~ 1 deg K.

H.London

536.48 : 532.78

ATOMIC DISTRIBUTION OF LIQUID He^4. See Abstr. 110

536.48 : 535.324

REFRACTIVE INDEX OF LIQUID He^4. See Abstr. 175

536.48

263. ON THE EXISTENCE OF A TANGENTIAL VELOCITY DISCONTINUITY OF THE SUPERFLUID COMPONENT OF HELIUM NEAR A WALL. G.A.Gamtsemlidze.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1434-7 (1958). In Russian.

The appearance of a velocity discontinuity in the superfluid component of helium II moving with respect to a solid wall is studied experimentally. It is assumed that the formation of such discontinuity surfaces requires application of a minimal stress which is manifested as a threshold shear stress. Apparatus was constructed which permits one to determine the limiting displacement stress with a high degree of accuracy. The measurements revealed that the tangential velocity discontinuity of the superconducting part of helium II does not appear near the wall.

536 5 : 530.16

264. INCOMPLETE EQUILIBRIUM AND TEMPERATURE MEASUREMENT. C.M.Herzfeld.
J. Washington Acad. Sci., Vol. 46, No. 9, 269-75 (Sept., 1956).

The concept of temperature is discussed from the points of view of classical thermodynamics and statistical mechanics. The relation between relaxation phenomena and temperature measurement is explained, and several examples discussed qualitatively. Some methods for the measurement of temperature are examined in terms of the relation between relaxation and temperature. The methods considered cover several distinct types of situations encountered at high temperatures, and estimates are given of the reliability of the more modern methods.

536.5.081

265. THE REPRODUCIBILITY OF THE STEAM POINT. R.J.Berry.
Canad. J. Phys., Vol. 36, No. 6, 740-60 (June, 1958).

A steam-point apparatus and precision manometer were constructed in connection with the realization of the International Temperature Scale at the National Research Council (Canada). By means of this apparatus the steam point may be realized to 0.0002 deg C, with a reproducibility of 0.0001 deg C; the difference is due to uncertainties in the physical constants involved. The manometer is capable of measuring pressures of from 0 to 85 cm Hg with a precision of 1 μ, using electrostatic capacitance detection of the mercury surfaces and end standards to determine the height. The steam boiler gives constant results for a wide variety of operating conditions and has been used to show the increase of temperature with increasing head of water vapour. The triple-point cells used in these experiments show a similar temperature change with change of immersion. It has been shown that a period of 1 to 3 days is required for them to establish temperature equilibrium, after which they are constant to within 0.0001 deg C. The resistance thermometer used is extremely stable at the steam and triple points if it is carefully handled.

536.5.081

266. CALIBRATION OF TEMPERATURE MEASURING INSTRUMENTS.
Notes appl. Sci. Nat. Phys. Lab., No. 12, 47 pp. (1955).

536.512

267. THE INFLUENCE OF RATE OF COOLING ON THE ZEROS OF MERCURY-IN-GLASS THERMOMETERS. S.van Dijk, J.A.Hall and V.M.Leaver.
J. sci. Instrum., Vol. 35, No. 9, 334-8 (Sept., 1958).

A study of the effect of rate of cooling on the temporary depression of the zero of high-range mercury thermometers was made from two points of view. It is concluded that if the cooling rate is sufficiently slow (about 15 hr to cool from 400°C to room temperature) the temporary depression is completely suppressed. It is also concluded that from the point of view of a "permanence of range" or "bulb stability" test, the best discrimination between different batches of thermometers is obtained when the zeros are determined after slow cooling.

536.531

268. USE OF A CONSTANT CURRENT HOT WIRE FOR THE MEASUREMENT OF EXTREME TEMPERATURES. S.A.Hoenig.
Rev. sci. Instrum., Vol. 29, No. 8, 704-5 (Aug., 1958).

The theory of the constant-current hot-wire circuit for the measurement of very high gas temperatures is developed and it is shown that such a system may be used above the melting point of the wire itself.

536.627

269. A CALORIMETER FOR DETERMINATION OF HEATS OF WETTING. A.J.Groszek.
Nature (London), Vol. 182, 1152-3 (Oct. 25, 1958).

Details of a calorimeter with 13 thermocouples suitable for the determination of heats of adsorption as low as 0.001 cal/g are illustrated and described. It consists essentially of a cell kept at a constant temperature and filled with an adsorbent, the thermocouples (in direct contact with the adsorbent), and a jacketting arrangement. A liquid flows at a constant rate through the cell and the heat of adsorption of the liquid on the solid is evaluated by reproducing the temperature rise by an electric heater situated within the cell. The time of a determination is about 30 min. The temperature rises produced by the wetting of silica gel by a number of organic liquids are shown graphically.

S.Weintroub

536.632

270. SPECIFIC HEAT OF LIQUID OZONE. R.I.Brabets and T.E.Waterman.
J. chem. Phys., Vol. 28, No. 6, 1212-14 (June, 1958).

The specific heat was measured over a temperature range from 97° to 121°K. The heat capacity was found to be a linear function of temperature and is represented by the equation

$$C_p = 0.425 + 0.0014(T - 90) \text{ cal/g deg C.}$$

This equation is considered sufficiently accurate for engineering purposes over the temperature range from 90° to 150°K. Thus, the values of 0.425 and 0.509 cal/g deg C are reported for the specific heat of liquid ozone at 90° and 150°K, respectively.

THERMODYNAMICS

536.71

271. GENERALIZED THERMODYNAMIC PROPERTIES OF DIATOMIC AND TRIATOMIC GASES. B.E.Saltzman.
Industr. engng. Chem., Vol. 50, No. 10, 1593-8 (Oct., 1958).

Ideal (low pressure) heat capacity data and related properties for 23 diatomic and triatomic gases may be represented (within 1%) over wide ranges of temperature by two empirical constants for each substance in terms of the corresponding properties of air and of water. Simplified corrections for high pressures are given. P_C and T_C and one constant for each substance give both the vapour pressure and heat of vaporization over the entire liquid temperature range. The relationships are convenient to use in nomographic form.

W.Good

536.71 : 534.222.2

EQUATION OF STATE OF BURNED EXPLOSIVE GAS IN SHOCK WAVE PRODUCTION. See Abstr. 143

536.711 : 523.75

EXPANSION AND SHOCK FLOW IN PROMINENCES. See Abstr. 9

ELECTRICITY

ELECTROSTATICS. DIELECTRICS

537.226

272. ANISOTROPIC EFFECTS IN GEOMETRICALLY ISOTROPIC LATTICES. Z.A.Kaprielian.
J. appl. Phys., Vol. 29, No. 7, 1052-63 (July, 1958).

For spacings and element dimensions small with respect to wavelength the dielectric constant of a completely general lattice of identical elements may be represented by a tensor (k_e). In many applications of artificial dielectrics it is important that the dielectric act as an isotropic medium for microwaves. This requires that (k_e) reduces to a scalar. The dielectric constant tensor will reduce to a scalar only if the lattice is cubical and the geometry and the material of the elements are restricted so that the induced fields may be represented by a set of three mutually perpendicular static dipoles at the lattice points. Isotropy further requires that the moment of the resultant dipoles be proportional to the inducing field and that the proportionality factor be a scalar independent of direction. However, at shorter wavelengths, the representation of the lattice elements by static dipoles will not be valid and the medium becomes anisotropic. This paper evaluates the anisotropy produced by an arbitrary ratio of element spacing to wavelength, and demonstrates that there is a basic anisotropy associated with the granularity of an array composed of isotropic elements arranged in structurally isotropic patterns.

537.226.1

273. THE ELECTRIC ANALOGUE TO ANTIFERROMAGNETISM: ANTIFERROELECTRICITY. H.Gränicher.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1220-3 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

537.226.2 : 532.77

274. DIELECTRIC PROPERTIES OF AQUEOUS AND ALCOHOLIC ELECTROLYTIC SOLUTIONS.
J.B.Hasted and G.W.Roderick.
J. chem. Phys., Vol. 29, No. 1, 17-26 (July, 1958).

Results of dielectric constant and loss measurements on a range of aqueous and alcoholic electrolytes at wavelengths of 1.25, 3.2, 9.9, 17, and 51.5 cm from 3°C to 25°C are analysed in terms of dielectric constant depression, relaxation time depression and spread, and conductivity elevation. The small relaxation time spread ($\alpha \sim 0.02$) is interpreted as being due to hydrogen bond bending, the relaxation time depression as bond breaking, and the dielectric constant depression as restriction of dipole rotation by the ions. The conductivity elevation is believed to be an effect of the same type as that observed by Little and Smith. It is shown that the alcohol dielectric constant depression is too large to be interpreted in terms of dipole restriction by solvation so that the ion must have a marked effect on the alcohol structure.

537.226.2 : 535.376

DIELECTRICAL PROPERTIES OF ELECTROLUMINESCENT AND PHOSPHORESCENT ZINC SULPHIDES. See Abstr. 216

537.226.2 : 535.323

275. ELECTRICAL AND OPTICAL PROPERTIES OF SYNTHETIC CALCIUM TITANATE CRYSTAL.
A.Linz, Jr and K.Herrington.
J. chem. Phys., Vol. 28, No. 5, 824-5 (May, 1958).

The optical density of a flame fusion single crystal plate of $CaTiO_3$ is reported. The refractive indices for the visible region are given, with $n_D = 2.403 \pm 0.02$. The results of dielectric constant and loss measurements over the temperature range from 90 to 430°K reveal no unusual behaviour. A room-temperature dielectric constant of 190 is reported.

537.226.2

276. FERROELECTRICITY IN $NaNO_2$.
S.Sawada, S.Nomura, S.Fujii and I.Yoshida.
Phys. Rev. Letters, Vol. 1, No. 9, 320-1 (Nov. 1, 1958).

Sodium nitrite crystals were formed by fusion from dry powder. They were ferroelectric below the well-known transition temperature of 160°C. Pyroelectric measurements showed that the spontaneous polarization was 7 $\mu C/cm^2$, but 50 c/s hysteresis loops could be observed only at high temperatures, due to the high coercivity. The transition seems to be of the first kind, and ferroelectricity to result from the ordered arrangement of the O—N—O groups.

R.C.Kell

537.226.2

277. DOMAIN EFFECTS IN POLYCRYSTALLINE BARIUM TITANATE. E.C.Subbarao, M.C.McQuarrie and W.R.Buessem.
J. appl. Phys., Vol. 28, No. 10, 1194-200 (Oct., 1957).

Upon depoling ceramic barium titanate, up to 9% of the domains reorient by 90°, indicating that during poling at least this percentage of the domains were permanently reoriented by 90°. Ceramic barium titanate shows a strong anelastic effect in the ferroelectric state, presumably due to domain reorientations under stress. Application of tensile and compressive stresses causes up to 13% of the domains to change their orientation by 90°, but, unlike the electric case, no permanent domain reorientation is found. These domain switches are detected by X-ray intensity and strain measurements. The agreement between the per cent domain switches computed from the X-ray data and that computed from the strain data is good in the case of mechanical compression, but not in the case of electrical and mechanical tension. In the latter case more domains appear to switch in the bulk than in the surface of the material. A space-charge effect at the surface of ferroelectric barium titanate is suggested as a reason for this anomaly. Experimental evidence of the effect of grinding, etching, and irradiation on the domain orientation in the surface layer of ceramic barium titanate is cited.

537.226.2

278. PHENOMENOLOGICAL THEORY OF POLARIZATION REVERSAL IN $BaTiO_3$ SINGLE CRYSTALS.
C.F.Pulvari and W.Kuebler.
J. appl. Phys., Vol. 29, No. 9, 1315-21 (Sept., 1958).

A theory describing polarization reversal in $BaTiO_3$ c-domain crystals based on observed time and field dependence of polarization $P = f(E,t)$ is presented, and the activation field α as well as mobility μ are related to the constants appearing in the basic differential equation. The theory gives time and field dependence of the switching current at constant temperature. Although the theory does not imply restriction on the applied field E(t), results are given only for pulsed and sinusoidal fields. The effect of skin properties on the bulk crystal is considered. Dependence of coercive field on applied field and frequency are readily obtained. Switching resistance is calculated.

537.226.2

279. THE PROBLEM OF THE NATURE OF THE HIGH PERMITTIVITY OBSERVED IN CERTAIN SOLID SOLUTIONS WHICH EXHIBIT FERROELECTRIC PROPERTIES. V.A Bokov.
Zh. tekh. Fiz., Vol. 27, No. 8, 1784-93 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1657-66 (Aug., 1957).

The paper investigates the dependence of ϵ and $\tan \delta$ on temperature in weak electric fields for a number of solid solutions: $(Ba,Sr)TiO_3$, $Ba(Ti,Sn)O_3$ and $Ba(Ti,Zr)O_3$. On the basis of available data on the temperature dependence of the coercive force and

domain mobility an explanation is given for the nature of the temperature dependence of tan δ. The high values of ε for certain solid solutions are explained in terms of their appreciable orientational polarization. A study is made of the dependence of hysteresis losses per cycle on the alternating field intensity. In the range of fields that are not very strong these losses are proportional to the cube of the field intensity.

537.226.33 : 532.77

280. DIELECTRIC RELAXATION IN SOLUTIONS WITH LARGE SOLUTE MOLECULES. R.J.Meakins.
Trans Faraday Soc., Vol. 54, Pt 8, 1160-5 (Aug., 1958).

Gives the results of dielectric measurements of solutions of polar solutes having an unusually wide range of molecular size. It is found that, when the solute molecule is at least three times as large as the solvent molecule, the solutions give good agreement with Debye's equation: $\tau = 4\pi\eta a^3/kT$.

537.226.8 : 550.837

281. A THEORETICAL STUDY OF INDUCED ELECTRICAL POLARIZATION. R.H.Frische and H.von Buttlar.
Geophysics, Vol. 22, No. 3, 688-706 (July, 1957).

An expression is obtained (and numerically evaluated) for determining the depth to a saturated aquifer when prospecting for ground water by induced electrical polarization. In a horizontally stratified earth model consisting of a non-polarizable overburden and an underlying, infinitely deep polarizable layer, the induced-polarization potential difference for a Wenner electrode configuration is nearly independent of the resistivity contrast. The computation agrees with results from a laboratory model tank and with a field curve. This justifies confidence in the validity of the results obtained from the model tank earth models too complex for computation.

537.226.8 : 621.315.61

282. SOME EFFECTS OF NONUNIFORM [ELECTRIC] FIELDS ON DIELECTRICS. H.A.Pohl.
J. appl. Phys., Vol. 29, No. 8, 1182-8 (Aug., 1958).

Experimental and theoretical studies show the effects to be rather striking for particles larger than molecular size. The results show that the effect can be used to produce a fairly efficient pumping action of non-conducting liquids, to cause continuous and easily measurable separations in coarse suspensions, to cause selective precipitation, and to produce mixing. By this means, liquids may be thrown several feet into the air with an electromechanical efficiency of about 25%. A separation factor of at least 2.5 in continuous separation operation may be produced in a suspension of polyvinyl chloride in carbon tetrachloride–benzene mixture. Suspensions of polar materials in less polar liquids may be either dispersed or precipitated. In one "demonstration" type of experiment, drops were "hung" in mid air.

537.227

283. PRIMARY PYROELECTRICITY IN BARIUM TITANATE CERAMICS. T.A.Perls, T.J.Diesel and W.I.Dobrov.
J. appl. Phys., Vol. 29, No. 9, 1297-302 (Sept., 1958).

Data were obtained on the pyroelectric and piezoelectric behaviour of samples of a polycrystalline barium titanate ceramic in an effort to determine the possible existence of a primary pyroelectric effect. It is shown that the total pyroelectric effects is in a direction opposite to the piezoelectric contribution resulting from volumetric changes and that, as a consequence, there must exist a primary pyroelectric effect. The time constant of the samples for generation of electrical signals from heat pulses was less than 12 μsec. Practical applications of barium titanate sensors may be found in the measurement of heat radiation beams having large cross-sections.

537.228.1

284. PIEZOELECTRIC EFFECT IN INDIUM ANTIMONIDE. J.H.Wasilik and R.B.Flippen.
Phys. Rev. Letters, Vol. 1, No. 7, 233-4 (Oct. 1, 1958).

The In-Sb lattice has no centre of symmetry, but the piezoelectric effect cannot be detected at room temperature because of high conductivity. Thickness-mode resonances were detected at 78° K and 4.2° K in a sample containing a p–n junction, and therefore of relatively high resistance. In a p-type sample, these resonances could be detected only at 4.2° K. R.C.Kell

ELECTRIC CONDUCTION. SEMICONDUCTORS

537.311.1

285. ON ELECTRONIC CURRENT IN NiO. J.Yamashita and T.Kurosawa.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 34-43 (1958).

Conduction by movement of an extra electron which is tightly bound to an ion in an ionic lattice is discussed. It is assumed that the wave-function of the electron is localized closely around an ion and the motion of the electron is so slow that lattice polarization is induced around the electron. In this case the conduction mechanism may not be explained by the usual band theory, but it may be better to use a Heitler–London picture and to interpret the current as a result of wandering of the electron from ion to ion. This conduction mechanism is used to explain the electronic current which appears in NiO and $LaMnO_3$ crystals.

537.311.31

286. THE TEMPERATURE-DEPENDENT AND TEMPERATURE-INDEPENDENT PARTS OF THE INCREASE OF RESISTANCE DUE TO IMPURITIES IN A METAL. A SIMPLE METHOD OF OBTAINING THEIR RATIO. A.N.Gerritsen and J.M.L.C. van der Aa.
Appl. sci. Res. A, Vol. 6, No. 2-3, 191-6 (1956).

A linear relation between the average temperature coefficient of resistivity of a diluted alloy between 273° and 373° K and the residual resistance measured below 4° K gives a quantitative determination of the ratio between the temperature-dependent and temperature-independent parts of the increase of resistance of the base metal caused by alloying. A linear relation being valid for a range of concentrations of the solute metal below 1 atom per cent, this ratio is a constant for a given binary alloy. For a few arbitrarily chosen cases of gold- and copper-alloys with nickel, iron and cobalt, the ratio proves to be smaller than 0.1 determined at 273° K.

537.311.31 : 536.422.1

EFFECT OF STRONG ELECTRIC FIELDS ON THE ELECTRICAL RESISTANCE OF METALS. See Abstr. 257

537.311.32 : 536.212.3

287. LOW TEMPERATURE RESISTIVITY OF THE TRANSITION ELEMENTS: RUTHENIUM AND OSMIUM. G.K.White and S.B.Woods.
Canad. J. Phys., Vol. 36, No. 7, 875-83 (July, 1958).

Experimental values are reported for the electrical resistivity of ruthenium and osmium from 2° to 300° K and for the thermal resistivity from 2° to 140° K. The samples were produced by arc-melting pressed pellets of metallic powder in an inert gas atmosphere. Two osmium samples and one ruthenium sample showed a satisfactorily low residual electrical resistance. By grinding these rods to a regular shape, absolute values of resistivity were obtained and the impurity and thermal components of resistivity derived; at room temperature (295° K) it was deduced that for ideally pure Os, $\rho \cong 9.1_3\ \mu$ ohm cm and for ideally pure ruthenium $\rho \cong 7.3_7\ \mu$ ohm cm. The temperature dependence of the resistivity was markedly different for another ruthenium sample but it seems likely that this was not representative of pure h.c.p. ruthenium.

537.311.32

288. THE TRANSIENT CONDUCTIVITY INCREASE IN DEFORMED ALKALI HALIDES. A.Taylor and P.L.Pratt.
Phil. Mag. (Eighth Ser.), Vol. 3, 1051-2 (Sept., 1958).

The conductivity increase was only observed at an advanced stage of deformation, when systems of slip bands, originating in separate blocks of the crystal, were beginning to penetrate each other. It is deduced that the conductivity enhancement is due to lattice vacancies generated when dislocations intersect.

K.W.Plessner

537.311.33

289. PROPERTIES OF SEMICONDUCTORS. H.Y.Fan.
Nuovo Cimento Suppl., Vol. 7, No. 2, 661-95 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

537.311.33

290. SEMICONDUCTING COMPOUNDS. G.A.Busch.
Nuovo Cimento Suppl., Vol. 7, No. 2, 696-712 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

537.311.33

291. SHALLOW IMPURITY STATES IN SEMICONDUCTORS. W.Kohn.
Nuovo Cimento Suppl., Vol. 7, No. 2, 713-23 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

537.311.33

292. SEMICONDUCTOR WITH SMALL APPARENT CARRIER MASS. O.Madelung.
Nuovo Cimento Suppl., Vol. 7, No. 2, 730-6 (1958). In German.
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

537.311.33

293. SIMPLIFIED THEORY OF ONE-CARRIER CURRENTS WITH FIELD-DEPENDENT MOBILITIES. M.A.Lampert.
J. appl. Phys., Vol. 29, No. 7, 1082-90 (July, 1958).
A general method is presented for the calculation of steady-state, one-carrier currents in non-metallic solids where the mobility is field dependent. The analysis includes the effects of space charge and trapping. The essential mathematical step is the representation of the electric-field intensity as a polynomial in the drift velocity. Detailed applications are made to semiconductor and insulator problems. A new mobility function of convenient mathematical form is proposed for the case that the carrier has a constant mean free path. Some very general properties of the current flow are established by geometric analysis.

537.311.33 : 538.22

294. ELECTRICAL RESISTIVITY OF COMPOUNDS WITH ORDERED SPIN ARRANGEMENTS. R.Parker.
Phil. Mag. (Eighth Ser.), Vol. 3, 853-61 (Aug., 1958).
A summary is given of the published data for electrical resistivity of semiconductors which exhibit ordered spin arrangements below a Curie or Néel temperature. It is found generally that electrical anomalies accompany the advent of magnetic order only if the specific resistivity at the transformation temperature is less than a critical value. The implications of this rule are discussed in the light of recent theories of electrical conduction in spontaneously magnetized materials.

537.311.33

295. GRAPHICAL ANALYSIS OF THE TEMPERATURE DEPENDENCE OF THE ELECTRONIC POPULATION IN SEMICONDUCTORS. G.Brouwer.
Philips Res. Rep., Vol. 12, No. 5, 415-22 (Oct., 1957).
The distribution of electrons and holes in semiconductors and its variation with temperature may be derived by means of a graphical approximation. The method is based directly on the electronic reaction equation in the equilibrium case.

537.311.33

296. THE CHANGE OF CARRIER CONCENTRATION IN THE SIMPLE SEMICONDUCTORS WITH STATIC MAGNETIC FIELD. Y.Uemura and M.Inoue.
J. Phys. Soc. Japan, Vol. 13, No. 4, 377-81 (April, 1958).
The change of carrier concentration with static magnetic field is discussed by using the simple model of the semiconductors. Attention is mainly focused on whether the concentration of free carriers increases or decreases with the field. The situations are classified into three cases [A], [B] and [C] according to the degree of concentration of the centres. [A] The concentration of the trapping centres is dilute and a centre can trap only one carrier. In this case the carrier concentration n is a monotonously decreasing function of the field H, namely $dn/dH^2 \geq 0$, [B] The impurity levels lose the locality and form a band, the so called "impurity band", the width of which is smaller than kT. In this case one obtains

$$(dn/dH^2)_{\text{weak H}} > 0 \qquad \text{when } (m/m^*) < \sqrt{3\delta}$$
$$(dn/dH^2)_{\text{weak H}} < 0 \qquad \text{when } (m/m^*) > \sqrt{3\delta}$$

where m^* is the effective mass of carriers and δ means the degree of compensation, namely $\delta = (N_d - N)/N_d$. [C] The width of the impurity band is larger than kT and the Fermi level ζ_0 at H = 0 lies in this band. In this case one obtains

$$(dn/dH)_{\text{weak H}} > 0 \qquad \text{when } (m/m^*) < \sqrt{3(1-s)}$$

where

$$s = kT\left[\frac{\partial}{\partial E}\log D(E)\right]_{E=\zeta_0}$$

D(E) being the state density of the impurity band. It seems that there is no possibility of explaining the so-called "magneto-conductive" phenomena observed in p-InSb from this standpoint.

537.311.33

297. THE CHANGE OF CARRIER CONCENTRATION IN THE GRAPHITE WITH STATIC MAGNETIC FIELD.
Y.Uemura and M.Inoue.
J. Phys. Soc. Japan, Vol. 13, No. 4, 382-8 (April, 1958).
The change of carrier concentration with static magnetic field in a single crystal of graphite is considered and the Hall coefficient R is discussed from this point of view. Wallace's model of the two dimensional zone and its orbital quantization proposed by McClure are the starting point of the analysis. Comparing with Kinchin's experiment, it is proposed that the acceptor levels exist at 11×10^{-3} eV above the bottom of the conduction band and their concentration is 1.7×10^{18} cm^{-3}. Wallace's resonance integral γ_0 is estimated as 1.43 eV semiempirically. The ratio of the mobilities of two carriers $b = \mu_p/\mu_n = 0.87$ gives the best fit of R at the low temperature under the strong magnetic field. By using these values of the parameters, the Hall coefficient R is plotted as a function of temperature and magnetic field. The agreement with experimental data is good except in the low field region.

537.311.33

298. AMPLIFICATION OF SPACE-CHARGE WAVES IN SEMICONDUCTORS. E.Groschwitz.
Z. Naturforsch., Vol. 12a, No. 6, 529-32 (1957). In German.
The phenomenological (average values of the state variables) equations of motion, field distribution and continuity for a Lorentz electron gas are stated. A preliminary discussion of the solution of these equations is given. R.Stratton

537.311.33

299. RECOMBINATION PROCESSES IN SEMICONDUCTORS. P.Aigrain.
Nuovo Cimento Suppl., Vol. 7, No. 2, 724-9 (1958).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

537.311.33

300. PARAMAGNETIC RESONANCE OF IMPURITIES IN A SEMICONDUCTOR. A.Abragam and J.Combrisson.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1197-212 (1957). In French.
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

537.311.33 : 538.66

301. ETTINGSHAUSEN EFFECT AND THERMOMAGNETIC COOLING. B.J.O'Brien and C.S.Wallace.
J. appl. Phys., Vol. 29, No. 7, 1010-12 (July, 1958).
The use of the Ettingshausen effect in refrigeration is considered. The phenomenological similarity of this cooling effect with the cooling by a cascade of Peltier couples is treated. Theoretical expressions are derived for the maximum cooling that is possible with the Ettingshausen effect, and it is shown that the optimum shape of the cooling element is an exponential of a given form. Preliminary experiments with bismuth alloys have given a cooling of about 0.25 deg C.

537.311.33 : 535.337 : 535.345

OPTICAL PROPERTIES OF SEMICONDUCTORS UNDER HYDROSTATIC PRESSURE. See Abstr. 208-9

537.311.33 : 538.63

302. GALVANOMAGNETIC EFFECTS IN P-TYPE BISMUTH TELLURIDE. J.R.Drabble.
Proc. Phys. Soc., Vol. 72, Pt 3, 380-90 (Sept., 1958).
The resistivity components, Hall coefficients and low field magneto-resistance coefficients were measured on a number of single crystal specimens at 77°K. The results are shown to be consistent with a many-valley form of the valence band for which the energy extrema are on the reflection planes in momentum space. The parameters associated with the model are evaluated and are used to obtain the relations between the Hall coefficients and the density of carriers. The results are used to discuss the variation of the resistivities and the Hall coefficients with temperature over the range 77°K to 290°K and, in particular, to obtain the conductivity mobility for holes for current flow parallel to the cleavage planes. This mobility varies as $T^{-1.98}$ and, for one specimen, has a value of 515 cm^2 V^{-1} sec^{-1} at 290°K.

537.311.33 : 537.322.4 : 538.63

303. MAGNETOTHERMAL RESISTANCE AND MAGNETO-THERMOELECTRIC EFFECTS IN BISMUTH TELLURIDE.
A.E.Bowley, R.Delves and H.J.Goldsmid.
Proc. Phys. Soc., Vol. 72, Pt 3, 401-10 (Sept., 1958).

The effects were measured for samples of p-type and n-type Bi_2Te_3 at 77°K. Scattering laws for the charge carriers are derived from the magnetothermoelectric effect and also from the magneto-thermal resistance effect for p-type material. It has, however, not been possible to fit a simple scattering law to the results from the magnetothermal resistance effect in n-type material.

537.311.33

304. OHMIC PROBE CONTACTS TO CdS CRYSTALS.
Y.T.Sihvonen and D.R.Boyd.
J. appl. Phys., Vol. 29, No. 8, 1143-5 (Aug., 1958).

Wire probe contacts are found to be diodic upon first touching CdS, but can be permanently changed from diodic to ohmic by the passage of a moderately intense electric current pulse. This result obtained for ten metals supports the idea that an exhaustion barrier exists on the surface, and contradicts proposals that ohmic contact is solely dependent upon the relative metal and CdS work functions. It is postulated that the current pulse punctures the exhaustion barrier, thereby permitting electrons to tunnel more freely and in greater numbers.

537.311.33

305. ZEEMAN SPLITTING OF DONOR STATES IN GERMANIUM.
R.R.Haering.
Canad. J. Phys., Vol. 36, No. 9, 1161-7 (Sept., 1958).

The linear Zeeman effect of the 2pm = ±1 donor states is calculated in the effective mass approximation. The resulting level splitting is independent of the longitudinal mass characterizing the ellipsoidal conduction band energy surfaces. This result is valid as long as the Zeeman splitting of the m = ±1 states is small compared to the energy difference between the 2pm = 0 and the 2pm = ±1 states. The Zeeman pattern to be expected in germanium is plotted as a function of the angle between the magnetic field and the (100) direction.

537.311.33 : 538.6

306. PHONON-DRAG THERMOMAGNETIC EFFECTS IN N-TYPE GERMANIUM. I. GENERAL SURVEY.
C.Herring, T.H.Geballe and J.E.Kunzler.
Phys. Rev., Vol. 111, No. 1, 36-57 (July 1, 1958).

In a magnetic field $\vec{H}$ and a thermal gradient ∇T, a conductor develops a Nernst field $-B\vec{H} \times \nabla T$ and its thermoelectric power Q depends on $\vec{H}$. These two effects were measured for a number of single-crystal six-armed samples of high-purity n-type germanium with various orientations, at fields up to 18 000 gauss and at a number of temperatures from the liquid-hydrogen range to the onset of intrinsic conduction; the most detailed measurements were made near liquid air temperature. Both the Nernst coefficient B and the quantity $\Delta Q = Q(\vec{H}) - Q(0)$ are compounded additively out of terms arising from diffusion of the electrons and terms arising from their anisotropic scattering by the phonons moving from hot to cold. The latter "phonon-drag" terms are strongly predominant at low temperatures. They give rise to a positive contribution B_p to the low-field B which outweighs the negative electron-diffusion contribution for $T < 175°K$, and which can be expressed in terms of Hall mobility $\mu_{\vec{H}}$ and phonon-drag thermoelectric power Q_p by $B_p = \zeta_p |Q_p| \mu_H/c$ with $\zeta_p \cong 0.25$ over most of the range. Theoretically and experimentally, $BH \to 0$ as $H \to \infty$. As expected, $\Delta Q(\vec{H})$ resembles the magnetoresistance both in its anisotropy and in its variation with $\vec{H}$. All the results are understandable theoretically in terms of a model which assigns to each ellipsoidal energy shell in crystal-momentum space an anisotropic phonon-drag Peltier tensor with principal components $\Pi_{p\parallel}$ in the high-mass direction, $\Pi_{p\perp}$ in the low-mass direction. The data show that $\Pi_{p\parallel}/\Pi_{p\perp} \gg 1$ but $<$ the mass-relaxation-time anisotropy $m_\parallel {}^*\tau_\perp / m_\perp {}^*\tau_\parallel \cong 17$. The effective average of $\Pi_{p\parallel}$ and $\Pi_{p\perp}$ increases slightly with decreasing energy of the shell, as it should if the relaxation times of the phonons vary with wave number q at a rate between Π^{-1} and q^{-2}.

537.311.33

307. ELECTRICAL PROPERTIES OF GERMANIUM WITH ZINC IMPURITY. S.G.Kalashnikov, E.Yu.L'vova and V.V.Ostroborodova.
Zh. tekh. Fiz., Vol. 27, No. 9, 1925-30 (1957). In Russian.

An investigation was made of the influence of zinc impurity on Hall hole mobility, drift mobility of electrons and rate of recombination of non-equilibrium electrons in germanium. Comparison of the results for the Hall mobility of holes with analogous data for singly charged centres shows that the value of the mobility is approximately proportional to the square of the charge of scattering centres It is found that alloying germanium with zinc does not create effective centres of recombination, and therefore zinc is a good alloying element for producing hole germanium of low specific resistance but high electron lifetime. It is found that the upper limit of the effective cross-section of recombination of atoms of zinc for electrons does not exceed 10^{-19} cm^2.

537.311.33

308. RECOMBINATION AT THE THREE LEVELS OF COPPER ATOMS IN GERMANIUM, TAKING INTO ACCOUNT THE STATISTICS OF THEIR ELECTRON OCCUPATION. T.V.Mashovets.
Zh. tekh. Fiz., Vol. 28, No. 6, 1140-50 (1958). In Russian.

Measurements of the resistivity, ρ, and lifetime, τ, were made on Ge specimens (originally 27 ohm cm) into which thermal acceptors had been introduced by heating for various times at controlled temperatures (550°-800° C). Results are presented graphically as a function of annealing time at the temperatures 700°, 750° and 800° C. The inhomogeneity of unsaturated specimens suggested that the thermal acceptors diffused in from the surface. A detailed analysis was made of the τ data for specimens saturated with thermal acceptors, assuming that each thermal acceptor was a substitutional Cu atom with three acceptor levels. The positions of the Fermi level, and hence ρ, were calculated as functions of the number of Cu atoms/cm^3, N, assuming 5×10^{13} donor centres per cm^3 to be present also. Using a Shockley—Read type theory for each level, the data on τ as a function of N (10^{13} to 10^{15}) was analysed to give the capture cross-sections of each level for holes (A_p) and electrons (A_n). The results were: 0.04 eV level, A_p and $A_n < 10^{-15}$ cm^2; 0.32 eV level, $A_p = 1.8 \times 10^{-16}$ cm^2, $A_n = 1.8 \times \times 10^{-17}$ cm^2; 0.46 eV level, $A_p = 3.6 \times 10^{-16}$ cm^2, $A_n = 3.6 \times 10^{-17}$ cm^2 (the energy levels being measured from the valence band edge). The 0.04 eV level always played a small role in the recombination and it was only possible to assign upper limits to the capture cross-sections. For $N < 10^{14}$ the 0.46 eV level dominated the recombination, but for $N > 10^{14}$ the 0.32 eV level became the most important.
K.F.Hulme

537.311.33

309. SURFACE MOBILITY IN GERMANIUM AND SILICON.
M.F.Millea and T.C.Hall.
Phys. Rev. Letters, Vol. 1, No. 8, 276-8 (Oct. 15, 1958).

Results of field effect measurements on an etched surface of n-type Ge and on an oxidized surface of n-type Si are compared with curves calculated using Schrieffer's treatment (Abstr. 2732/1955). Better agreement between experiment and theory is obtained by assuming partial, rather than complete, diffused scattering of carriers at the surface.
G.C.Williams

537.311.33 : 535.343

ABSORPTION OF LIGHT DUE TO CURRENT CARRIERS IN GERMANIUM. See Abstr. 196

537.311.33

310. ELECTRICAL PROPERTIES OF GERMANIUM TELLURIDE GeTe. S.Asanabe and A.Okazaki.
Mem. Fac. Sci. Kyūsyū Univ., Vol. 2, No. 4, 136-40 (Jan., 1958).

The material was prepared from highly purified Ge and Te. Resistivity and Hall effect were measured between 130° and 900° K, semi-metallic behaviour being found. The resistivity had a positive temperature coefficient throughout, while the Hall coefficient remained constant up to 500° K and then fell sharply. Doping with iodine reduced the Hall effect. In the brief discussion a parallel with the behaviour of SnTe is drawn.
K.W.Plessner

537.311.33

311. ON THE ELECTRIC CONDUCTIVITY OF LEAD(II)-OXIDE WITH ADDITIONS OF HIGH-ORDER IMPURITY CATIONS.
H.Grunewald and W.Neumann.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 6-8, 344-50 (1958).
In German.

The conductivity was studied over the range 0-2 molar per cent and 200-500° C for additions of the oxidies of chromium, neodynium and cerium. In general, the influence of the additions was slight and this is considered as additional evidence that the usual model of substitution defects is not operative here. (For previous work see Abstr. 6962-3/1958).
A.H.W.Beck

537.311.33

312. THE ELECTRICAL CONDUCTIVITY OF MANGANESE ARSENIDE AND ANTIMONIDE. G.Fischer and W.B.Pearson.
Canad. J. Phys., Vol. 36, No. 8, 1010-16 (Aug., 1958).

The electrical resistivity of MnAs in the paramagnetic range, where it is fairly independent of temperature, is about 5×10^{-4} ohm cm. In the ferromagnetic range it is about 2×10^{-4} ohm cm at 0°C with a temperature coefficient of 5×10^{-3} per deg C.

537.311.33 : 621.382

313. RADIATION INDUCED NOISE IN P–N JUNCTIONS. W.H.Fonger, J.J.Loferski and P.Rappaport.
J. appl. Phys., Vol. 29, No. 3, 588-91 (March, 1958).

Noise is induced in a p–n junction when it is bombarded by high-energy radiation. The mean-square noise current $d\langle(i_n)^2\rangle$ is predicted to be given by

$$d\langle(i_n)^2\rangle = 2e^2\langle N_B\rangle\langle m^2\rangle \Delta f,$$

where N_B is rate of incidence of bombarding particles and m is the number of hole–electron pairs which reach the junction per primary particle. Experiments performed on Ge and Si p–n junction diodes agreed with this prediction. Extension of the theory to triodes is outlined, and applications of the noise in detecting and analysing radiation are discussed.

537.311.33 : 621.382

314. THE INFLUENCE OF THE GEOMETRICAL AND PHYSICAL CONDITIONS AT THE POINT CONTACT OF GERMANIUM DIODES ON THE [CURRENT–VOLTAGE] CHARACTERISTICS. E. Hofmeister and E. Groschwitz.
Z. angew. Phys., Vol. 10, No. 3, 109-14 (March, 1958). In German.

The point-contact diode is analysed theoretically as a p–n junction with either cylindrical or spherical symmetry, and the necessary modifications to the Shockley equation for the current–voltage characteristic are expressed in terms of geometrical "form-factors". The minority carrier densities are assumed to have their thermodynamic equilibrium values at the metallic boundaries. Estimates of the "true" saturation currents of a number of experimental diodes were made by three methods, and are compared with theoretical estimates based on the analysis assuming a likely range of junction radii. The agreement is considered to be good.

F.F.Roberts

537.311.33 : 539.2

315. EFFECT OF DISLOCATIONS ON BREAKDOWN IN SILICON P–N JUNCTIONS. A.G.Chynoweth and G.L.Pearson.
J. appl. Phys., Vol. 29, No. 7, 1103-10 (July, 1958).

The light emission patterns of silicon diffused p–n junctions at breakdown were compared with the etch-pit patterns that reveal dislocations. It is concluded that avalanche breakdown microplasmas occur preferentially where dislocations pass through the junction. In narrow p–n junctions, large numbers of dislocations result in enhanced internal field emission and, consequently, a soft reverse characteristic. A qualitative correlation is found between the nature of the light emission pattern (spots for avalanche breakdown, glow for field emission) and the quality of the reverse characteristic. Possible reasons why breakdown should occur preferentially at dislocations are discussed though no precise conclusion is reached. Peculiar singularities observed in the light emission patterns of some junctions were found to coincide with crystal abnormalities revealed in the etch patterns.

537.311.4

316. INDUCED CONDUCTIVITY AT THE SURFACE OF CONTACT BETWEEN METALS. S.D.Chatterjee and S.K.Sen.
Phil. Mag. (Eighth Ser.), Vol. 3, 839-52 (Aug., 1958).

It was found that when one of the alkali metals is brought into electrical contact with some other metals like aluminium, cadmium, magnesium, etc., the contact resistance of the junction undergoes remarkable variations under the influence of an electrical stress. The exact nature of the variation depends primarily upon the contact-combination of the metals. However, the nature and magnitude of the electrical pulse and polarizing voltage, the pressure applied to the surface junction, etc. play important roles in determining the finer characteristics of the variation. The present paper gives a brief account of investigations on the potassium–aluminium surface combination only. A tentative explanation of these phenomena is suggested on the basis of formation and disruption of an intermediate oxide layer under appropriate electrical conditions.

537.312.5

317. ANALYSIS OF THE PHOTOCONDUCTANCE IN SILICON. L.J. van der Pauw.
Philips Res. Rep., Vol. 12, No. 4, 364-76 (Aug., 1957).

A general formula is derived for the change in voltage drop across a semiconductor sample, caused by illumination. It is shown that this formula is a convenient starting point for analysing photoconductive experiments. In particular it is shown that in relevant cases white light may be used without difficulty. The analysis of the low-frequency phase-shift between the voltage drop and the light signal as a function of the thickness of the sample yields the values of the bulk lifetime, the surface-recombination velocity and the drift mobility of the minority charge carriers. Also the properties of traps can be determined. The results of some measurements at room temperature are discussed.

537.312.5

318. PHOTO-CARRIER DIFFUSION IN CdS SINGLE CRYSTALS. V.Ye.Lashkar'ov, H.A.Fedorus and M.K.Sheĭnkman.
Ukrayin. Fiz. Zh., Vol. 2, No. 4, 374-5 (1957). In Ukrainian.

Continuation of the work reported in Abstr. 1066 (1958).

C.R.S.Manders

537.312.62

319. THEORY OF SUPERCONDUCTIVITY. J.R.Schrieffer.
Nuovo Cimento Suppl., Vol. 7, No. 2, 377-85 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

537.312.62

320. FAR INFRARED ENERGY GAP MEASUREMENTS IN BULK SUPERCONDUCTORS. P.L.Richards and M.Tinkham.
Phys. Rev. Letters, Vol. 1, No. 9, 318-20 (Nov. 1, 1958).

Using infrared techniques, the surface resistances of superconducting lead and tin were measured in the wavelength range 0.15-2 mm. As the quantum energy reached the value sufficient to excite electrons across the energy gap, there was a sudden onset of absorption, which soon approached that in the normal state. This onset was twice as fast as predicted by the Bardeen–Cooper–Schrieffer theory. The width of the energy gap in Pb (at 0°K) was deduced to be $(4.1 \pm 0.2)\ kT_c$, and that in Sn $(3.4 \pm 0.3)\ kT_c$, values to be compared with the theoretical value $3.5\ kT_c$ which should hold for all superconductors.

L.Pincherle

537.312.62

321. EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE SUPERCONDUCTING-NORMAL TRANSITION AND ITS CONVERSE FOR A HOLLOW CYLINDER IN A CIRCULAR MAGNETIC FIELD. M.Näbauer.
Z. Phys., Vol. 152, No. 3, 328-67 (1958). In German.

The transitions were studied in an electro-polished single-crystal hollow cylinder of Pb at 4.2°K. The circular field was provided by a toroidal coil wound over the cylinder, and the flux changes in a similar coil observed oscillographically. The results are compared with those predicted theoretically, assuming a cylindrical phase boundary. Good agreement is found except in the initial stages of the transition; it is suggested that here the boundary has not yet become a cylinder.

R.G.Chambers

537.32

322. ON THE THEORY OF THERMOELECTRICITY. R.Haase.
Z.Naturforsch., Vol. 11a, No. 9, 681-4 (1956). In German.

The difference between the thermal conductivity of a conductor in the absence of an electric field and the thermal conductivity in the absence of an electric current is expressed in terms of the transportable heat of the electrons, which may be regarded as the mean kinetic energy of the electrons which constitute the current. An expression giving an upper limit for the transportable heat is derived, and also an expression relating it to the Thomson coefficient.

P.M.Davidson

537.322

323. SOPHOMORE EXPERIMENT IN THERMOELECTRICITY. J.H.Noon and B.J.O'Brien.
Amer. J. Phys., Vol. 26, No. 6, 373-5 (Sept., 1958).

A laboratory experiment is described in which the temperature change caused at the junction of two metals is studied for both directions of current through the junction. It extends the usual thermocouple-calibration experiment and encourages consideration of thermoelectric cooling as a possible source of refrigeration.

537.322.1

324. PELTIER HEAT AT THE INTERFACE BETWEEN A METAL AND ITS MELT. J.M.Bardeen and B.S.Chandrasekhar.
J. appl. Phys., Vol. 29, No. 9, 1372-3 (Sept., 1958).

The Peltier coefficient at the solid–melt interface of various metals was determined, and results are given for Bi, Cd and Zn. The theory of the method, which depends upon observation of the movement of the interface, is given. Experiments were carried out on bars about 20 cm long and 0.5 cm^2 cross-sectional area.

M.R.Hopkins

537.322.4 : 538.63 : 537.311.33

MAGNETOTHERMOELECTRIC EFFECTS IN BISMUTH TELLURIDE. See Abstr. 303

537.323

325. THERMOELECTRIC PROPERTIES OF ANTIMONY TELLURIDE AND OF SOLID SOLUTIONS OF Sb_2Te_3–Bi_2Te_3. H.Benel.
C.R. Acad. Sci. (Paris), Vol. 247, No. 5, 584-7 (Aug. 4, 1958). In French.

The thermoelectric power 83μV/deg C, resistivity 4×10^{-4} ohm cm, and thermal conductivity 8×10^{-3} cal cm^{-1} sec^{-1} deg C^{-1} of Sb_2Te_3 are unaffected by small additions of Te or Sb or of several other doping agents. The same properties of solid solutions of Bi_2Te_3 and Sb_2Te_3 are sensitive to composition and to added Te.

C.A.Hogarth

ELECTRIC DISCHARGES

537.523.4 : 539.19

326. THE ELECTRIC STRENGTH AND MOLECULAR STRUCTURE OF HYDROCARBON GASES. A.E.D.Heylen and T.J.Lewis.
Canad. J. Phys., Vol. 36, No. 6, 721-39 (June, 1958).

Precise measurements of the sparking potentials of a number of hydrocarbon gases over a wide range of pressure and electrode spacing are reported. The range of gases includes the n-paraffins up to n-octane and the olefins up to hexene-1. The effect of the triple bond in acetylene and conjugation in butadiene, as well as the effects of cyclization, are included. Careful experimental control involving the observation of prebreakdown pulses is an important feature of the measurements, and all the gases tested were of the highest purity. A theory is given, relating the sparking potentials V_S to the molecular structure of the gases. This assumes a Townsend criterion for breakdown and a particular expression for the Townsend α coefficient. It is then possible to obtain information concerning the relative electron-scattering cross-sections of these hydrocarbons, which are related not to the molecular bonds as has been suggested earlier, but to individual atomic groups. With such a model, CH_3 and CH_2 groups involving double or triple bonds have characteristic cross-sections. The theory then becomes closely allied to that for the ultraviolet spectra of these hydrocarbons. It appears that the present system of description is a more natural one than that involving bond cross-sections. It is believed that dissociation occurs readily on many hydrocarbons and that photon action is small. This produces a value of γ (the second Townsend coefficient) which is very small ($\sim 10^{-8}$) in comparison with the value ($\sim 10^{-4}$) in more common gases. Such a low value can account for the considerable pulse activity observed in these hydrocarbon gases before breakdown occurs. Few pulses were observed in cyclopentane and cyclohexane, which do not dissociate readily; and it appears that a more usual value of $\gamma = 0^{-4}$ occurs in these particular gases.

537.523.5

327. STUDIES OF SHORT A.C. ARCS IN AIR. I. H.Nöske.
Z. angew. Phys., Vol. 10, No. 7, 327-36 (July, 1958). In German.

Describes experiments made with arcs between contacts, with mm spacings (0.9-3.3 mm approx.). Voltage–time oscillograms are given. Restriking characteristics etc. were studied in terms of various parameters. The effects of cathode oxide surface films were studied and are discussed; cathode spots (arcing points) are also described.

J.D.Craggs

537.525.4

328. THE ELECTRICAL BREAKDOWN OF SMALL GAPS IN VACUUM. A.S.Denholm.
Canad. J. Phys., Vol. 36, No. 4, 476-93 (April, 1958).

An investigation of the electrical breakdown in vacuum of small gaps subject to contamination by diffusion pump oil showed that the most consistent results were obtained when electrodes were conditioned by a hydrogen discharge. Even with this method of conditioning a few preliminary sparks were usually required before the breakdown voltage reached a plateau level, so that the vacuum discharge itself could affect the final values obtained. The circuit parameters which controlled the discharge current were found to influence the magnitude and consistency of the breakdown voltage appreciably. Direct, alternating, and impulse voltage tests showed that the time for which voltage was applied to the vacuum gap influenced the breakdown voltage, and curves are presented which give the insulation strength of the gap. Two possible explanations of the time dependence of the breakdown voltage are given.

537.525.92

329. THE THEORY OF THE POSITIVE COLUMN IN ELECTRONEGATIVE GASES. M.V.Konyukov.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1634-5 (1958). In Russian.

It is pointed out that the dissociation of negative ions upon collision with neutral atoms somewhat complicates the simple picture of the gas discharge previously advanced by the author (Abstr. 7066/1958). It is shown that there are three distinct values of ion concentration which correspond to different physical conditions. The two extreme conditions correspond to the cases where there is an excess of either created or vanishing ions and the intermediate case is one of balance. If account is taken of re-combination of positive and negative ions, generally speaking a column can be divided into two regions. In the near region recombination exceeds creation and in the external region the reverse is true.

S.C.Dunn

537.527.4

330. CONTRIBUTION TO THE THEORY OF DEVELOPMENT OF A SPARK CHANNEL. S.I.Braginskii.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1548-57 (1958). In Russian.

The principle processes taking place in a spark channel at moderate currents and comparatively high pressures are examined. Solutions are obtained which describe the movement of the gas outside the channel. A new type of hydrodynamic jump is considered: a strong discontinuity with external supply of heat. Some solutions which describe the state of the gas within the channel and also some expressions for the characteristic channel parameters (radius, temperature etc.) are obtained.

X-RAYS

537.531 : 535.345 : 539.12

331. DETERMINATION OF X-RAY ABSORPTION COEFFICIENTS OF INHOMOGENEOUS MATERIALS.
S.Ergun and V.H.Tiensuu.
J. appl. Phys., Vol. 29, No. 6, 946-9 (June, 1958).

A method was developed for determining X-ray absorption coefficients of inhomogeneous materials. It involves comparison of the reflected and transmitted intensities from the same specimen at various scattering angles. The difference in the geometry of the reflection and transmission techniques permits calculation of the absorption coefficient from the observed intensities. Evaluation of the absorption coefficient at different angles overcomes the uncertainties of the conventional method caused by small angle scattering, white radiation, crystalline mineral impurities, etc., and eliminates the necessity of measuring the intensity of the primary beam. The method is not limited to X-rays; it is equally applicable to γ-rays, neutrons, and visible light.

A.

537.531 : 535.31

332. X-RAY OPTICAL IMAGING ON A NaCl CRYSTAL PLATE DEFORMED INTO A SPHERICAL SHELL. H.Haudek.
Z. angew. Phys., Vol. 9, No. 2, 73-82 (Feb., 1957). In German.

Methods by which the crystal plates were plastically deformed are described. Their shape and texture were investigated by optical interference and by Laue photographs. X-ray images of a wire gauze were formed by means of bent crystal plates as reflectors. Various factors limiting the resolving power are considered.

A.R.Stokes

ELECTRON EMISSION. ELECTRON BEAMS

537.533 : 538.3 : 621.385.833

333. COMMENT ON MAGNETIC FORCES AND RELATIVISTIC SPEEDS IN STATIONARY ELECTRON BEAMS. J.M.Winwood.

J. Electronics and Control, Vol. 5, No. 2, 161-2 (Aug., 1958).

Criticism of discussion by Meltzer (Abstr. 7082/1958) of relative magnitudes of magnetic and electrostatic forces in electron beams. Three errors in the application of the theory of the Lorentz transformation lead to an estimate of the ratio of magnetic to electric force between two moving electric charges, different from Meltzer's.

B.Meltzer

537.533.2

334. THEORY OF PHOTOELECTRIC EMISSION.
P.Görlich and H.Hora.
Optik, Vol. 15, No. 2-3, 116-26 (Feb.-March, 1958). In German.

A distinction is made between the photoelectric emission from metals in the long-wave region (conduction band emission) and in the shorter wave region (localized level emission). Localized level emission occurs from Cs_3Sb photocathodes in the visible region; the theory developed for Cs_3Sb is applied to photo-emission from metals in the far u.v. Extension of the theory to the conduction band case is considered.

J.Franks

537.533.2

335. MEASUREMENT OF SECONDARY ELECTRON EMISSION FROM SELENIUM. G.Oertel.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 6-8, 305-18 (1958). In German.

The temperature dependence and energy distribution of secondary emission from selenium with small percentages of added Br and Te were measured with primary beam energies up to 2500 eV.

C.G.Morgan

537.533.3

336. DIFFRACTION AND INTERFERENCE IN ELECTRON OPTICS. J.Faget and C.Fert.
Cahiers de Phys., Vol. 11, 285-96 (July, 1957). In French.

The subject is briefly reviewed; then follows a description of the authors' experiments with the electron-optical biprism of Möllenstedt and Duker. Improvements in the method are described. The biprism, used in conjunction with an electron microscope, enables inner potential measurements to be made on thin films of the type used in electron microscopy.

A.E.I. Research Laboratory

537.533.33

337. A COMPARISON OF THE SPHERICAL ABERRATION OF WEAK ELECTROSTATIC AND MAGNETIC ELECTRON LENSES.
R.Gobrecht.
Exper. Tech. der Phys., Vol. 4, No. 5, 215-31 (1956). In German.

The spherical aberration coefficient of electrostatic (cylinder) immersion lenses and air cored magnetic lenses is determined experimentally and compared from the point of view of cathode-ray tube practice. Extensive data are given in tabular form.

A.E.I. Research Laboratory

537.533.331 : 621.385.833

338. NUMERICAL CALCULATION OF THE ELECTROSTATIC IMMERSION OBJECTIVE. E.Hahn.
Optik, Vol. 15, No. 8, 500-16 (Aug., 1958). In German.

The field in an electrostatic immersion objective is explored mathematically and its focusing properties are found. An improved method is given for calculating the field distribution for given boundary conditions, which involve the position and dimensions of the cathode, Wehnelt electrode and anode and their relative potentials. The axial potential distribution and its derivatives are smoothed by a new process. For a given form of the electrodes, the position of the principal, focal and image planes are then calculated in function of the Wehnelt potential. The chromatic and spherical aberrations are calculated for three values of this potential.

V.E.Cosslett

537.533.35

339. SOURCES OF ERROR IN ELECTRON STEREOMICROSCOPY. R.I.Garrod and J.F.Nankivell.
Brit. J. appl. Phys., Vol. 9, No. 6, 214-18 (June, 1958).

A theoretical examination is made of the use of the stereoscopic technique for the determination of vertical elevations in electron microscope specimens. It is shown that the variation in optical object distance due to tilting the specimen may introduce serious errors even for object points close to the optic axis of the microscope. Other possible sources of error are also analysed, and it is concluded that in practice, apart from limits due to resolution, these are likely to be of minor importance in relation to the tilt error and the precision attainable in the measurement of parallax. Consideration is given to possible means of reducing the tilt error: no wholly satisfactory solution is found, and it is necessary for precision work to maintain the axis of tilt of the specimen close to the optic axis within very narrow limits.

537.533.35

340. EXPERIMENT ON THE ELECTRON PHASE MICROSCOPE.
K.Kanaya, H.Kawakatsu, K.Itō and H.Yotsumoto.
J. appl. Phys., Vol. 29, No. 7, 1046-9 (July, 1958).

A method of phase microscopy is described which offers greater image contrasts for specimens possessing small phase differences than is possible with conventional methods of electron microscopy. It is shown that observation by dark-contrast image using a phase-plate, consisting of many holes in a carbon membrane, is very suitable for microtome section specimens, as well as for thin crystal specimens, without a decrease in resolving power.

537.533.7.07

341. ELECTRON ABSORPTION SPECTROMETER USING AN IMPROVED VELOCITY ANALYZER. L.Marton and J.A.Simpson.
Rev. sci. Instrum., Vol. 29, No. 7, 567-70 (July, 1958).

The spectrometer uses the principle of individually designed stages for deceleration, dispersion, and re-acceleration. The instrument is usable over an energy range from 1 to 50 keV, and can obtain angular distribution data over a range of ±0.1 rad. The angular resolution is better than 10^{-8} rad. The demonstrated energy resolution at 20 keV is 0.6 eV. This resolution appears to be limited by the primary beam energy spread which is characteristic of a beam produced by a telefocus gun with tungsten cathode.

537.533.74

342. EFFECTS OF CONTAMINATION ON THE CHARACTERISTIC LOSS SPECTRUM OF TUNGSTEN.
C.J.Powell, J.L.Robins and J.B.Swan.
Phys. Rev., Vol. 110, No. 3, 657-60 (May 1, 1958).

Two types of contamination, the adsorption of a monolayer of atmospheric gas and the deposition of carbonaceous material under electron bombardment, were found to affect the characteristic electron energy-loss spectrum of tungsten. Spectra were obtained by analysing with a 127^0 electrostatic spectrometer the energy distribution of 850 V electrons scattered by the target through 90^0. The deposition of the carbonaceous material was associated with the growth of the carbon Auger peak. Each type of contamination could be removed by heating the target in vacuum to a suitable temperature.

537.533.75 : 537.534.75

343. ENERGY LOSS AND RANGE OF ELECTRONS AND POSITRONS. A.T.Nelms.
Circ. Nat. Bur. Stand., No. 577 Suppl., 31 pp. (1958).

Tabulations of the mean energy loss due to ionization and excitation, which include the density effect and the range derived from this quantity, are given for electrons and positrons in several materials.

537.533.79

344. IMPROVED ELECTRICAL DIFFERENTIATION OF RETARDING POTENTIAL MEASUREMENTS.
L.B.Leder and J.A.Simpson.
Rev. sci. Instrum., Vol. 29, No. 7, 571-4 (July, 1958).

An improved system for obtaining differential spectra from retarding potential measurements by the superposition of a small a.c. signal on the retarding voltage was developed. The principal improvements are the choice of the point of injection of the modulation signal, the use of a low impedance preamplifier to improve the accuracy of the energy scale, and the use of a synchronous detector to improve the stability and reduce the effect of noise. The energy profile of a 15 keV electron beam and the characteristic energy loss spectra in collodion and aluminium were measured. The quality of these measurements illustrates the over-all performance of the system.

537.533.8/.9 : 537.226.2

345. INTERACTION OF LOW-ENERGY ELECTRONS WITH FERROELECTRIC MATERIALS. R.C.Miller and R.D.Heidenreich.
J. appl. Phys., Vol. 29, No. 6, 957-63 (June, 1958).

Some of the effects of low-energy electron bombardment on $BaTiO_3$ and triglycine sulphate were investigated. It is found that the secondary electron emission characteristics allow one to reverse the spontaneous polarization in these materials when the

energy of the bombarding electrons is varied through the first cross-over. The switching time is determined by the rate at which charge can be built up on the bombarded surface and is limited by the primary electron beam current density. The two stable surface states characteristic of insulators are clearly seen, and transitions between the two can be made without reversing the polarization. There is no indication that the secondary electron yield in the neighbourhood of the first cross-over depends on the direction of the spontaneous polarization in the ferroelectric material. The resistivities of triglycine sulphate and $BaTiO_3$ were estimated from the switching transients. These materials exhibit a deterioration in their ferroelectric properties with time of electron bombardment.

ION EMISSION. ION BEAMS

537.534.3

346. ON THE DISPLACEMENT OF AN ION BEAM IMAGE BY MAGNETIC FRINGING FIELDS. L.Kerwin.
Canad. J. Phys., Vol. 36, No. 6, 711-20 (June, 1958).

Some of the methods proposed for calculating the effect of the magnetic fringing field on the image position of an ion beam are reviewed, and applied to the case of a particular instrument. The differences between the calculated corrections and the observed image suggest an improved method of calculating the image position. Applied to the case under consideration, this method gives essentially the correct image position.

537.534.3

347. AN ION MICROSCOPE FOR THE INVESTIGATION OF BIOLOGICAL TISSUE SECTIONS. G.Popp and W.Walcher.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 293-302 (1957). In German.

The distribution of the alkalis in biological tissue were investigated in the mass spectrometer. Ashed specimens of 100 A thickness gave an adequate yield of Na^+ and K^+ ions for the purposes of ion microscopy. An ion microscope was then designed to give direct imaging of the histological structure of biological tissue at a magnification of 100. A.E.I. Research Laboratory

537.534.3

348. MASS SPECTROMETERS WITH DOUBLE FOCUSING OF THE SECOND ORDER. H.Hintenberger and L.A.König.
Z. Naturforsch., Vol. 12a, No. 10, 773-85 (1957). In German.

The authors propose a double focusing mass spectrometer free from second-order aberration, whether due to aperture defect or to chromatic error. The design follows the solution of a complicated set of equations containing five arbitrary design parameters; these equations have been solved numerically. Designs using complementary deflection appear to be a practical possibility.
A.E.I. Research Laboratory

PARTICLE ACCELERATORS

537.54

349. HARD FOCUSING IN LINEAR ELECTRON ACCELERATORS.
K.N.Stepanov and A.A.Sharshanov.
Zh. tekh. Fiz., Vol. 27, No. 8, 1863-9 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1734-41 (Aug., 1957).

The paper studies the radial motion of a highly relativistic electron.

537.54

350. RADIATION EFFECTS IN CIRCULAR ELECTRON ACCELERATORS. K.W.Robinson.
Phys. Rev., Vol. 111, No. 2, 373-80 (July 15, 1958).

The effects of the radiation emission on the motion of electrons in high-energy synchrotrons are analysed. The damping rates and quantum excitation of the three principal modes of oscillation are derived for strong focusing and constant gradient accelerators. Methods for correcting the radiation effects for strong-focusing accelerators are discussed. A.

537.54

351. 24 MeV BETATRON OF OSAKA UNIVERSITY.
T.Asada, J.Furuta, M.Masuda, T.Koga, M.Okumura, E.Hiraoka, J. Ookuma and H.Fujita.
Annu. Rep. Sci. Works Fac. Sci. Osaka Univ., Vol. 3, 25-33 (1955).

Brief description of the accelerator and some of its ancillary equipment, together with examples of its applications.

537.54

352. OSAKA UNIVERSITY 44 INCH CYCLOTRON.
S.Kikuchi, T.Wakatsuki, S.Yamaguchi, Y.Oda, J.Sanada, S.Yamabe, Y.Yoshizawa, M.Takeda, M.Nozawa, E.Okada, Y.Hirao, S.Kobayashi, M.Kondo, S.Ozaki, T.Kato, K.Okano, S.Kato C.Hu and Y.Koh.
Annu. Rep. Sci. Works Fac. Sci. Osaka Univ., Vol. 3, 1-24 (1955).

Detailed description of design, installation and ancillary equipment.

537.54

353. DESIGN OF REGENERATIVE EXTRACTORS FOR SYNCHROCYCLOTRONS. I. SMALL-AMPLITUDE EXTRACTION.
W.F.Stubbins.
Rev. sci. Instrum., Vol. 29, No. 8, 722-5 (Aug., 1958).

The extraction of particles from the non-linear magnetic field of a synchrocyclotron by a single magnetic perturbation is studied by use of a general approximation to the magnetic field and a calculation technique closely tied to the physical process. The analysis is useful for extraction amplitudes of several inches. Regenerator strengths are computed as an example.

537.54

354. HIGH-ENERGY PARTICLE NOMOGRAPH.
D.B.Hoisington.
I.R.E. Trans Nuclear Sci., Vol. NS-4, No. 2, 62-3 (Dec., 1957).

A nomograph is presented for calculations related to the design of high-energy particle accelerators. Rest mass is given in the range from 0.0001 to 100 atomic mass units, with the energy equivalent of this mass in electron volts. The final velocity and mass of the particle are given for a range of energies from 5000 to 10^{15} eV. The equation for particle velocity is given in the form

$$v/c = [1 - 1/(1 + E/E_0)^2]^{1/2},$$

where E is the particle energy and E_0 is the energy equivalent of its rest mass. The frequency required for operation of a proton synchrotron is determined to illustrate the use of the nomograph.

537.54 : 539.1.07

355. PRODUCTION OF MILLIMICROSECOND PULSES BY RADIO-FREQUENCY SWEEPING OF THE ION BEAM IN THE TERMINAL OF AN ELECTROSTATIC ACCELERATOR.
C.M.Turner and S.D.Bloom.
Rev. sci. Instrum., Vol. 29, No. 6, 480-7 (June, 1958).

Apparatus was installed in the high-voltage terminal of the Brookhaven National Laboratory research electrostatic accelerator for production of ion current pulses in the millimicrosecond range by r.f. sweeping of the beam across a limiting aperture between the ion source and acceleration tube. Proton and deuteron pulses with a full width at half maximum of about 4.5 mμsec are presently available, with a pulse repetition time of 134 mμsec and an average current of 1-2 μA. A simple electrostatic refractor rejects alternate pulses to give one pulse per r.f. cycle. The advantages of this method are: (1) it minimizes the production of background radiations by ions which are not used on the target; (2) the reduced duty factor makes it potentially possible to correspondingly increase the instantaneous intensity during pulses. The usefulness of the system was demonstrated by the measurement of the delayed de-excitation by γ emission of the first excited state in B^{10}.

IONIZATION. PLASMA

537.56

356. DIFFUSION AND ELASTIC COLLISION LOSSES OF THE "FAST ELECTRONS" IN PLASMAS. G.Medicus.
J. appl. Phys., Vol. 29, No. 6, 903-8 (June, 1958).

When the energy spectrum of plasma electrons consists of two clearly separable groups (a high-energy, primary, non-Maxwellian, and a low-energy, secondary, Maxwellian one) the characteristic linear part of the corresponding probe curves, extrapolated to plasma potential, directly determines the random current density of the fast group. With a hemispherical anode and a hollow hot cathode near its centre, in Ne of about 1 mm Hg pressure, the flow of the fast group at low diode currents follows closely the spherical case of diffusion. The experimental data, by means of the diffusion law, can be evaluated for the mean free path l of the fast electrons. It

is found that l is independent of the plasma density and is about equal to the value calculated from the cross-section function for 10-16 V electrons in Ne. The diffusion law being applicable, the elastic collision losses of the fast group can be calculated. They are found to be relatively small compared with the total energy losses of the fast electrons. The results have been used in an attempt to determine the energy transfer from the fast group to the Maxwellian group. The most remarkable result is the low interaction of the fast group with the Maxwellian group at low total plasma densities where the partial density of the slow group is always comparable to or even much higher than that of the fast group.

537.56

357. THE MAXIMUM DISTURBANCE GROWTH RATE FOR AN UNSTABLE PLASMA COLUMN. S.Kaneko.
J. Phys. Soc. Japan, Vol. 13, No. 8, 947-53 (Aug., 1958).

A dispersion relation for a self-pinched plasma column enclosed by a conducting wall is derived for the case of a model with both surface sheet current and uniform volume current. On the basis of this dispersion relation, the maximum disturbance growth-rate for the instability is calculated. Both the uniform volume current and longitudinal magnetic flux outside the plasma column decrease the stability and make the growth-rate faster, the effect of the magnetic flux being larger.

537.56 : 538.3

358. HEATING OF A CONFINED PLASMA BY OSCILLATING ELECTROMAGNETIC FIELDS. J.M.Berger, W.A.Newcomb, J.M.Dawson, E.A.Frieman, R.M.Kulsrud and A.Lenard.
Phys. of Fluids, Vol. 1, No. 4, 301-7 (July-Aug., 1958).

There are two ways of heating a plasma confined by a strong axial magnetic field: (1) the electric field is parallel to the magnetic field, the situation that obtains in ohmic heating; (2) the electric field is perpendicular to the main axial magnetic field. In this paper the second method is considered for the case where the electric field is produced by an externally imposed oscillation of the axial field. As far as the heating of the plasma is concerned, there are four characteristic times which play a fundamental role: (1) the collision time, (2) the period of the oscillating field, (3) the time of transit of a typical ion through the heating region, and (4) the cyclotron period of an ion. If these four characteristic times are all of comparable order, the theoretical analysis is exceedingly complex. Therefore, four cases were considered in which these were taken to be of different orders. The heating mechanism differs in each of these four cases since the period of the externally produced electric field is chosen to be comparable to one of the characteristic times in the analysis. In each of the four cases configurations were found which led theoretically, at least, to efficient heating of the plasma. In those cases where the energy imparted to the plasma appears in the form of wave motion, the subsequent damping of these waves is discussed.

537.56 : 532.5 : 538.3

359. GENERATION AND THERMALIZATION OF PLASMA WAVES. T.H.Stix.
Phys. of Fluids, Vol. 1, No. 4, 308-17 (July-Aug., 1958).

Generation of hydromagnetic and ion cyclotron waves by an induction coil is considered for a cylindrical plasma in a uniform confining magnetic field. Resonance widths are calculated and power absorption is calculated and compared to ohmic losses in the induction coil. Rapid thermalization of transverse plasma waves occurs when appreciable numbers of ions stream through the periodic perturbation with velocities such that, in their own rest frames, these ions "feel" the perturbation at their own cyclotron frequency. This effect (cyclotron damping) makes possible an efficient plasma heating scheme for thermonuclear reactors. Radio-frequency power can be transferred from an induction coil into ion cyclotron waves with an efficiency typically greater than 65%. The wave energy can be quickly transformed into energy of effectively random transverse ion motion by causing the ion cyclotron wave to travel along a magnetic field which decreases slowly with distance.

537.56

360. OBSERVATIONS ON THE PLASMA PRODUCED IN A MAGNETIC MIRROR GEOMETRY. W.B.Johnson.
Phys. Rev. Letters, Vol. 1, No. 9, 333-5 (Nov. 1, 1958).

Rotating-drum photographs were taken of the discharge in a xenon plasma excited by oscillatory current in two single-turn magnetic field coils. Maximum field at coil centres was about 50 000 gauss and mirror ratio two. The photographs are interpreted as showing the collision of two plasma fronts approaching each other from opposite directions and simultaneously collapsing towards the axis. Estimates of radial and axial velocities are given.

B.Meltzer

537.56 : 532.5 : 538.3

361. OSCILLATIONS OF A PLASMA CYLINDER IN AN EXTERNAL MAGNETIC FIELD. K.Körper.
Z. Naturforsch., Vol. 12a, No. 10, 815-21 (1957). In German.

The oscillations of a plasma cylinder of infinite length are analysed. The plasma is assumed to be homogeneous and to be exposed to a static homogeneous magnetic field in axial direction. There are two different types of oscillation. In one case the induced current is parallel to the magnetic field, and is therefore not influenced by it. In the other, where the induced current is perpendicular to the field, two resonance frequencies exist. In the limit of small density and high magnetic field these are the gyrofrequencies of the ions and the electrons. The index of refraction for both types in the limit of small frequencies is that of the hydromagnetic waves. From the basic equations the energy conservation theorem is derived. Besides the usual terms giving the electromagnetic radiation, Joule's losses, and the electromagnetic energy density, it contains the kinetic energy of the ions and electrons of the plasma.

537.56

362. ON ELECTRON PLASMA OSCILLATIONS IN EXTERNAL ELECTRIC AND MAGNETIC FIELDS.
K.N.Stepanov and V.S.Tkalich.
Zh. tekh. Fiz., Vol. 28, No. 8, 1789-800 (1958). In Russian.

A mathematical paper. The dispersion equation is derived for oscillations within an infinite electron plasma situated in crossed electric and magnetic fields. It is supposed that the frequency of oscillation is so high that ionic motion can be neglected. Particular attention is paid to the case of a curl field.

S.C.Dunn

537.562 : 541.124

363. A MASS SPECTROMETRIC STUDY OF NORMAL OXYGEN AND OXYGEN SUBJECTED TO ELECTRICAL DISCHARGE.
J.T.Herron and H.I.Schiff.
Canad. J. Chem., Vol. 36, No. 8, 1159-70 (Aug., 1958).

A mass spectrometric study was made of oxygen activated by microwave and by a.c. glow discharge. Appearance potential curves for normal oxygen at masses 16 and 32 indicated the occurrence of multiple electron impact processes. The change in the curves when the oxygen was activated could be interpreted by assuming the presence of O-atoms in the P^3 ground state, and O_2 molecules in the $^1\Delta g$ excited states. No evidence was obtained for the presence of ozone up to pressures of 2 mm Hg. The recombination coefficient of O-atoms on pyrex was found to be 1.1×10^{-4}. Only one oxygen atom in 21 was ionized before recombining in the mass spectrometer ion source. The rate constant for the reaction of O-atoms with N_2O is less than 1×10^{-8} cm^3 mole^{-1} sec^{-1}, and several orders of magnitude less than this for the reaction $O(^3P) + N_2O \rightarrow 2NO$. The reaction of O-atoms with NO_2 was much faster than with NO, but no evidence was found for the formation of NO_3.

537.562

364. MASS SPECTRA OF SOME SIMPLE ESTERS AND THEIR INTERPRETATION BY QUASI-EQUILIBRIUM THEORY.
A.B.King and F.A.Long.
J. chem. Phys., Vol. 29, No. 2, 374-82 (Aug., 1958).

Mass spectra and appearance potential data are reported for normal and isotopically labelled methyl formate, methyl acetate, and ethyl formate, and reaction mechanisms are proposed for the production of the spectra. The data are analysed from the standpoint of the quasi-equilibrium theory of Eyring and co-workers. For the data from 70 V ionizing electrons, frequency factors can be adjusted so that the calculated patterns agree well with the experimental data. These frequency factors seem qualitatively satisfactory although there are some difficulties with the values for some of the rearrangements and hydrogen abstraction processes. However the theory is clearly inadequate at lower ionizing voltages. The probable explanation is that the electronic states are in narrow bands which do not overlap, so that at low voltages a portion of the ionic fragments are produced by direction dissociation, without the redistribution of energy which is required by the quasi-equilibrium theory.

537.562 : 533.15

365. THERMAL DIFFUSION IN IONIZED GASES. S.Chapman.
Proc. Phys. Soc., Vol. 72, Pt 3, 353-62 (Sept., 1958).

Thermal diffusion in mixed gases depends on a "thermal diffusion factor" α, which is less than unity in all known neutral gas mixtures (in which the particles have no electric charge). In simple ionized gases α exceeds unity, being of order $Z + 1$, where Ze is the charge on the ions. However, in the steady state of such a gas, at non-uniform temperature, thermal diffusion does not produce a concentration gradient of the electrons relative to the ions; instead it

sets up an electric field, which keeps the gas electrically neutral almost everywhere. In an ionized atmosphere subject to gravity, in which the temperature increases upwards, this electric field opposes and reduces the electric field that keeps the electrons and ions together, despite the great difference between their masses. The thermal diffusion factor seems to be greatest for the ions of different kinds in a mixed ionized gas, composed mainly of electrons and light ions of small charge Ze, with a small admixture of heavy ions of greater charge Z'e. In this case α is of order 2.5 $(Z'/Z)^2$, and can amount to several hundred. In such a gas, at non-uniform temperature, thermal diffusion can much increase the (still small) proportion of the heavy multiple ions in the hotter regions. The electric field that keeps the electrons with the ions, so that the gas is neutral, reinforces this tendency of the multiple ions, in the cases here considered. This tendency may have some importance in the solar corona, if turbulence is not too great and temperature inequalities persist long enough. It seems likely also that thermal diffusion will influence the distribution of the multiple ions present in the ZETA nuclear fusion apparatus.

537.562

366. THE EXPERIMENTAL DETERMINATION OF THE PRIMARY IONIZATION COEFFICIENTS AT LOW GAS PRESSURES. E.Jones and F.Llewellyn Jones.
Proc. Phys. Soc., Vol. 72, Pt 3, 363-8 (Sept., 1958).

An assessment of the method used to measure values of the Townsend primary coefficient of ionization at low pressures is given. This shows that the secondary processes of ionization must, in general, be taken into consideration in the analysis of the data, especially at pressures of the order of a few mm Hg, in order to obtain accurate values of α/p_0.

537.564

367. CHARGE EXCHANGE CROSS SECTIONS FOR HELIUM IONS IN GASES. C.F.Barnett and P.M.Stier.
Phys. Rev., Vol. 109, No. 2, 385-90 (Jan. 15, 1958).

The charge-exchange cross-sections were determined for a helium ion beam in several stopping gases. The cross-sections for electron loss by a fast helium atom (σ_{01}) and for electron capture by an ion (σ_{10}) are reported for energies between 4 and 200 keV. The target gases studied were hydrogen, helium, nitrogen, oxygen, neon, and argon. The value of σ_{01} increases monotonically throughout the energy range for all gases studied, obtaining values of 10^{-16} cm^2 at 200 keV. In all stopping gases except helium, σ_{10} passes through a maximum of approximately 3×10^{-16} cm^2 near 50 keV, whereas for helium this cross-section decreases throughout the energy range as expected for the resonant exchange reaction. Evidence is presented that the metastable excited state of the helium atom is of importance in the charge-exchange process.

537.564

368. ENERGY SPECTRUM OF ELECTRONS EMITTED FROM GASES BOMBARDED BY POSITIVE IONS.
D.E.Moe and O.H.Petsch.
Phys. Rev., Vol. 110, No. 6, 1358-61 (June 15, 1958).

The energy spectrum of electrons ejected during ionization of neon, argon and krypton by bombardment with potassium ions was experimentally determined. Energy selection was effected by the focusing property at 180° of a uniform magnetic field. The observed spectra consist of a structure of maxima and minima characteristic of the bombarded gas. The relative heights but not the positions of the maxima are functions of the incident ion energy.

537.564

369. DISSOCIATIVE ATTACHMENT OF ELECTRONS IN IODINE. I. MICROWAVE DETERMINATION OF THE ABSOLUTE CROSS SECTION AT 300°K. M.A.Biondi.
Phys. Rev., Vol. 109, No. 6, 2005-7 (March 15, 1958).

Microwave techniques are used to study electron attachment to iodine molecules during the afterglow following a pulsed discharge in an iodine–helium mixture. The helium gas decreases the ambipolar diffusion loss of the electrons and assures that the electrons are in thermal equilibrium with the gas during the afterglow. It is shown that under the experimental conditions electron attachment is the dominant electron-loss process. The measured cross-section for electron attachment to iodine at 300°K is $\sigma_a = 3.9 \times 10^{-16}$ cm^2.

537.564

370. DISSOCIATIVE ATTACHMENT OF ELECTRONS IN IODINE. II. MASS SPECTROGRAPHIC DETERMINATION OF THE ENERGY DEPENDENCE OF THE CROSS SECTION. R.E.Fox.
Phys. Rev., Vol. 109, No. 6, 2008-11 (March 15, 1958).

The energy dependence for electron attachment in iodine vapour is studied in a mass spectrometer and a total ionization tube using a collimated electron beam. The dissociative attachment process $I_2 + e \rightarrow I^- + I$ is found to be the only significant one. In the mass spectrometer the electron energy is determined by retarding potentials applied to the electron beam. In the total ionization tube a study of SF_6^- is used to establish the electron energy scale and to determine the electron energy distribution. These studies show that the maximum attachment cross-section occurs for essentially zero-energy electrons, and the measured cross-section decreases to half-value in about 0.03 eV. The mass spectrometer studies show the disturbing presence of I^- from hydrogen iodide which is presumed to be formed from the reaction of dissociated iodine with the water of crystallization in the glass.

537.564

371. DISSOCIATIVE ATTACHMENT OF ELECTRONS IN IODINE. III. DISCUSSION. M.A.Biondi and R.E.Fox.
Phys. Rev., Vol. 109, No. 6, 2012-14 (March 15, 1958).

The absolute cross-section, $\sigma(E)$, for electron attachment in iodine is determined from the measured values of the average cross-section, $\bar{\sigma}(E')$, described in Pts I and II of this series (see preceding abstracts). This is accomplished by solution of the integral equation relating the average cross-section, the actual cross-section, and the energy distribution of the electrons. The derived cross-section $\sigma(E)$ exhibits a much sharper energy dependence than that of $\bar{\sigma}(E')$ given in Pt II, decreasing from a maximum value at zero electron energy to a half-value in ~ 0.01 eV. The maximum cross-section $\sigma(0) \sim 3 \times 10^{-15}$ cm^2, is orders of magnitude larger than the values obtained by previous investigators. It is proposed that the difference in values can be attributed to deficiencies in measurements involving electron distributions of appreciable energy spread.

537.564 : 535.345

PHOTOIONIZATION COEFFICIENTS OF FURAN VAPOUR.
See Abstr. 206

537.565

372. ON THE MOBILITY OF POSITIVE IONS IN EXTREMELY PURE GASES AND GAS MIXTURES. R.Maushart.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, 264-80 (1958). In German.

A comprehensive study at low values of electric field to gas pressure ratio in carefully cleaned apparatus. Mobilities of ions in argon–oxygen, nitrogen–oxygen and water vapour mixtures were measured. From these data information is derived on the type of ion complexes present and their change with the proportions of the mixtures. 28 references. C.G.Morgan

537.565

373. MOBILITY OF GASEOUS IONS IN WEAK ELECTRIC FIELDS. E.A.Mason and H.W.Schamp, Jr.
Ann. Phys. (New York), Vol. 4, No. 3, 233-70 (July, 1958).

Kihara's extension (Abstr. 4560/1954) of the Chapman–Enskog theory of transport phenomena is used to obtain the second order and third order approximations to the mobility of gaseous ions in a weak electric field as a function of temperature and field strength. In this method it is assumed that there is no charge exchange between ions and molecules, there is no clustering, and that quantum effects can be neglected. The mobility is expressed as a series in ascending powers of the square of the field strength with coefficients which are complicated functions of the temperature, the mass ratio of the ions and molecules, and of the force law between the ions and molecules. The collision integrals which enter into the coefficients have been evaluated by numerical integration for a force law which takes into account the charge-induced dipole, charge-induced quadrupole, and the London dispersion forces, and an inverse twelfth power repulsion potential. In the potential energy function three disposable parameters specify the depth and position of the minimum and the relative magnitudes of various terms. The results of the present calculation are then used to analyse published experimental data on mobility to obtain the disposable parameters which determine the ion-molecule force law. The agreement between theory and experiment is good except for those cases in which clustering is to be expected.

537.565

374. DISTRIBUTION OF IONS AROUND CHARGED FINE WIRES. T.Shimizu.
J. Geomagn. Geoelect., Vol. 9, No. 2, 116-18 (1957).

COSMIC RAYS

537.591.1

375. THE CHARGE SPECTRUM OF THE COSMIC RADIATION AT 41°N. M.Koshiba, G.Schultz and M.Schein.
Nuovo Cimento, Vol. 9, No. 1, 1-16 (July 1, 1958).

From a large stack of G-5 emulsions flown at Texas, 41°N geomagnetic latitude, the charge spectrum of the cosmic radiation at 104 000 ft was obtained. Special emphasis is given to the observation of the detailed shape of the spectrum in the region $Z \geq 9$. The gap-counting is extensively used even at these high Z values after very careful calibration with break-up events and δ-ray countings. The charge spectrum thus obtained was extrapolated to the top of the atmosphere by making use of the fragmentation probabilities in air which were obtained from the analysis of a total of 209 interactions in the same stack. This extrapolation gives for the ratio of the light nuclei, L, ($Z = 3$, 4 and 5) and the heavy nuclei, H, ($Z \geq 9$), to the medium ones, M, ($Z = 6$, 7 and 8) the values 0.32 ± 0.07 and 0.48 ± 0.10, respectively, at the top of the atmosphere. The fragmentation probabilities in hydrogen, the main constituent of interstellar matter, were also obtained from the careful study of the interactions in the stack and allowed to make a further extrapolation of the charge spectrum from the top of the atmosphere to the one at the source region of the cosmic radiation. The ratio of the heavy nuclei to the medium ones was found to be 0.66 ± 1.6 at the source. This charge spectrum at the source region is compared with the average chemical abundances of the elements in the universe as well as with those in certain types of stars. The results seem to indicate a close similarity of the chemical abundance curve of the cosmic radiation with that of certain types of young stars.

537.591.15

376. NUMERICAL CALCULATIONS ON THE NEW APPROACH TO THE CASCADE THEORY. III.
S.K.Srinivasan, J.C.Butcher, B.A.Chartres and H.Messel.
Nuovo Cimento, Vol. 9, No. 1, 77-84 (July 1, 1958).

For previous work, see Abstr. 6317 (1957). On the basis of the new approach to the cascade theory accurate numerical results on the mean numbers of electrons produced in small thicknesses in a shower initiated by a single electron or photon are presented. Agreement with the experimental results is satisfactory if due allowance is made for tridents.

537.591.15

377. OBSERVATIONS ON EXTENSIVE AIR SHOWERS. VI. THE RATIO OF THE SOFT TO PENETRATING COMPONENTS AND THEIR ATTENUATION IN THE ATMOSPHERE. T.E.Cranshaw, J.F.de Beer, W.Galbraith, A.M.Hillas, S.Norris and N.A.Porter.
Phil. Mag. (Eighth Ser.), Vol. 3, 811-25 (Aug., 1958).

For Pt V, see Abstr. 3211 (1958). The paper describes measurements of the ratio of μ-mesons to electrons as a function of shower size and barometric pressure for showers containing about 5×10^6 particles at sea level. Measurements on the change of rate with atmospheric pressure and temperature are also described, and it is shown how, on the assumption that all showers suffer the same attenuation, these measurements yield the attenuation lengths of electrons and μ-mesons. At each stage, the measurements are compared with the results of other experiments, and finally with various theories of the nucleon cascade. It is shown that none of the theories fits the data well, and that one may suspect the assumption of similar attenuation for all showers. Possible mechanisms giving rise to a distribution of attenuation lengths are briefly discussed, and a case made for an experimental investigation of this point.

537.591.15

378. OBSERVATIONS ON EXTENSIVE AIR SHOWERS. VII. THE LATERAL DISTRIBUTION OF ENERGY IN THE ELECTRON–PHOTON COMPONENT. N.A.Porter, T.E.Cranshaw, J.F.de Beer, A.G.Parham and A.C.Sherwood.
Phil. Mag. (Eighth Ser.), Vol. 3, 826-30 (Aug., 1958).

The energy density of the electron–photon component was measured at distances of 60-500 metres from the axis of showers containing 3×10^6 particles at sea level. The mean electron energy appears to be constant, and close to the critical value of 84 MeV, over this region. A lower limit for the energy appearing in the soft component of these showers at sea level is set at 6×10^{14} eV.

537.591.15

379. ON A POSSIBLE MODE OF DEVELOPMENT OF EXTENSIVE ATMOSPHERIC SHOWERS.
N.L.Grigorov and V.Ya.Shestoperov.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1539-47 (1958). In Russian.

The development of extensive atmospheric showers is examined under the assumption that the fraction of energy lost in the interaction of ultra-high-energy particles with light nuclei strongly fluctuates. It is shown that the main features of extensive air showers can be explained without making recourse to the hypothesis that the nuclear component plays an important role in development of the showers in the depth of the atmosphere.

537.591.5

380. ELEVEN YEAR VARIATION OF COSMIC-RAY DISTURBANCE AND ITS RELATION TO SOLAR AND GEOMAGNETIC ACTIVITIES. Y.Miyazaki and M.Wada.
J. Geomagn. Geoelect., Vol. 7, No. 1-2, 1-8 (June, 1955).

537.591.5

381. THE DIURNAL VARIATION OF COSMIC RAYS.
K.Nagashima.
J. Geomagn. Geoelect., Vol. 7, No. 1-2, 51-68 (June, 1955).

The energy gain or loss of the primary cosmic ray produced by an electromagnetic field of a solar stream is examined, and the diurnal variation of cosmic rays during magnetic storms explained by this energy variation theory. The amplitudes and the times of the maximum intensity of the diurnal variations are calculated at various altitudes and latitudes.

537.591.5

382. DIURNAL VARIATION OF VERTICAL COSMIC RAYS — NARROW TOTAL AND HIGH ENERGY COMPONENTS.
T.Yagi and H.Ueno.
J. Geomagn. Geoelect., Vol. 8, No. 3, 93-107 (Sept., 1956).

537.591.5

383. SOLAR ACTIVITY AND COSMIC RADIATION. R.R.Brown.
J. Geomagn. Geoelect., Vol. 9, No. 2, 79-85 (1957).

Observations on the correlation of solar activity with cosmic radiation are reported. The relation of these results to models involving solar corpuscular streams is briefly considered.

537.591.5

384. THE PROBLEM OF FLUCTUATIONS OF A MIXED MESON–NUCLEON CASCADE IN THE ATMOSPHERE. S.Ganguly.
J. Technol. (Calcutta), Vol. 2, No. 2, 123-36 (Dec., 1957).

The theory of these fluctuations (initiated by a primary proton) is developed from the general continuity equations and the probability functions for the different particle numbers. Series solutions are obtained for the average numbers, as well as for the squared moments. Numerical results are presented for the case of three different primary energies. The Polya distribution with the adjustable parameter b is compared with the Poisson and Furry distributions.

537.591.5

385. THE ZENITHAL DISTRIBUTION OF THE COSMIC RAY NEUTRONS IN THE HIGH ENERGY RANGE.
M.C.Fidecaro, G.Fidecaro, G.Marini and L.Mezzetti.
Nuovo Cimento, Vol. 9, No. 1, 37-58 (July 1, 1958).

The zenith angle distribution of cosmic-ray neutrons in the energy range $> \sim 10$ GeV was measured at an altitude of 3500 m above sea level (679 g cm^{-2}) by means of a penetrating shower detector associated with a large area Geiger-counter hodoscope. The penetrating showers were generated in thin layers of paraffin and graphite. The instrumental bias and the systematic errors in the determination of the angles are discussed, and corrections applied whenever possible. The corrected distribution is well approximated with a law of the type $\exp[-m/\cos\theta]$ with $m = 7.1 \pm 1.3$, in agreement with the results of Walker. The discussion shows that this value has to be considered as a lower limit for the true m and is therefore difficult to reconcile with the assumption that the zenithal distribution is due solely to the absorption of the particles of the nuclear cascade in the atmosphere, with a mean free path $\lambda_a = 130$ g cm^{-2} as determined by several authors. From the hodoscope information the angular distribution of ionizing secondaries around the direction of the primary neutron in also calculated. The distributions obtained for penetrating showers produced in carbon and in hydrogen are very similar. The analysis in terms of an isotropic distribution in the centre of mass system of the incident neutron and a target nucleon yields an average energy of

the observed events $\bar{E}$ = 24 GeV. The experimental results on the zenithal distribution are compared with the distributions calculated with the theory of the nuclear cascade in the atmosphere, as developed by Budini and Molière. It is shown that the finite lifetime of some of the particles belonging to the N component cannot account for the "anomalous" zenithal effect indicated by the measurements. It is suggested that the discrepancy may be removed with the choice of a value of the anelasticity parameter much greater than that assumed by Budini and Molière.

MAGNETISM

538.082 : 621.317.444

386. IMPROVED [AUTOMATIC RECORDING] TORQUE MAGNETOMETER. W.S.Byrnes and R.G.Crawford.
J. appl. Phys., Vol. 29, No. 3, 493-5 (March, 1958).

This instrument will automatically plot the torque exerted on a thin ferromagnetic disk slowly rotating in a uniform magnetic field as a function of the angle between a reference direction in the disk and the direction of the applied field. The torque exerted on the disk is converted into a d.c. electrical signal. Conversion is accomplished by coupling the mechanical torque system to a strain gauge transducer whose electrical output is used to drive a d.c. strip-chart recorder. Emphasis is placed on various design features of the new magnetometer that are considered improvements over the original design due to Miller (Abstr. 8855/1950). In particular, improvements have been made on the bearings, shaft, and strip which constitute the important features of the instrument. Depending on the transducer that is used, the measurable torque range is 0 to 70×10^3 ergs. The sensitivity of the highest range is approximately 2×10^3 ergs/mV.

538.082.742

387. MEASUREMENT OF MAGNETIZATION CURVES IN HIGH PULSED MAGNETIC FIELDS. I.S.Jacobs and P.E.Lawrence.
Rev. sci. Instrum., Vol. 29, No. 8, 713-14 (Aug., 1958).

An extension of familiar techniques in magnetic measurements was made enabling the direct measurement of magnetization curves (M v. H) in high pulsed magnetic fields ($H >\sim 100$ kOe). The sample is placed in the most spatially uniform region of the available field, inside one of a pair of balanced and opposing pick-up coils. Their output is integrated and displayed on the vertical deflection plates of an oscilloscope as M, while the integrated output of the empty coil appears on the horizontal plates as H. A magnetization M of ~ 30 e.m.u. or a volume susceptibility of $\sim 5 \times 10^{-4}$ can be detected with reasonable, but not high accuracy. The method is better suited to non-linear magnetization curves than those methods which involve placing the sample in an inhomogeneous field, and hence may be useful in studying metamagnetics and weak antiferromagnetics.

538.113 : 539.19

388. PARAMAGNETISM IN DIAMAGNETIC MOLECULES. W.Weltner, Jr.
J. chem. Phys., Vol. 28, No. 3, 477-85 (March, 1958).

The experimental and theoretical determinations of the Van Vleck paramagnetic contribution (χ_{HF}) to the susceptibility of diamagnetic molecules are considered. The data on the hydrogen molecule are reviewed, and the mean square orbital angular momentum is recalculated by using Newell's wave-function. The H_2 calculations are interpreted as indicating that the main contributions to χ_{HF} are from energy levels directly adjacent to the double ionization limit (to H_2^{++}) at 51 eV. A corresponding calculation is made for methane by using approximate wave-functions and it is found that, contrary to the H_2 molecule work, L^2 is quite insensitive to the wave-function employed. An effective excitation energy of 30 eV is derived from an experimental value of χ_{HF} obtained from rotational magnetic moment data. Similar data for CH_3F are considered and explained by the inductive effect of the F atom upon the C–H bond dipole moment. Approximate rigid-charge calculations of χ_{HF} and Pascal's rule are discussed, and the higher hydrocarbons are treated by the above procedures. It is conjectured that, in general, the energy levels near the various ionization limits in a molecule are the principal contributors to χ_{HF}, and also, that relatively low effective excitation levels (order of magnitude about 50 eV) might be expected.

538.113

389. PARAMAGNETISM IN CRYSTALS. M.H.L.Pryce.
Nuovo Cimento Suppl., Vol. 6, No. 3, 817-56 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.113

390. PARAMAGNETIC RELAXATION. C.J.Gorter.
Nuovo Cimento Suppl., Vol. 6, No. 3, 887-94 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.113 : 539.14

391. MAGNETISM AT VERY LOW TEMPERATURES AND NUCLEAR ORIENTATION. N.Kurti.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1101-39 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.113 : 537.312.62

392. MAGNETIC PROPERTIES OF SUPERCONDUCTORS. C.J.Gorter.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1168-76 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.113

393. MAGNETIC SUSCEPTIBILITY OF ELECTRONS IN PERIODIC FIELDS. C.P.Enz.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1224-9 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.113

394. A NEW APPROACH TO THE DIAMAGNETIC ANISOTROPY OF BENZENE. THE ANISOTROPY OF σ-ELECTRONS. L.Singh.
Trans Faraday Soc., Vol. 54, Pt 8, 1117-19 (Aug., 1958).

It is shown that if a suitable correction for the anisotropy of σ-electrons is applied, then the calculated values of $\sqrt{(r^2)}$ for the bigger π-electron orbit in benzene derivatives agree very closely with the geometrical radius of the benzene ring. A correction for the discrepancy between the values of K_1 and K_2 in the plane of the nucleus is also proposed.

538.113

395. MAGNETIC PROPERTIES OF METALS. J.H.Van Vleck.
Nuovo Cimento Suppl., Vol. 6, No. 3, 857-86 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.113/.114

396. LINE-BREADTHS AND THE THEORY OF MAGNETISM. J.H. Van Vleck.
Nuovo Cimento Suppl., Vol. 6, No. 3, 993-1014 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.113/.114

397. STOCHASTIC THEORY OF MAGNETIC RESONANCE. R.Kubo.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1063-80 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.114

398. FERROMAGNETIC RESONANCE IN YTTRIUM IRON GARNET AT LOW FREQUENCIES. E.G.Spencer, R.C.LeCraw and C.S.Porter.
J. appl. Phys., Vol. 29, No. 3, 429-30 (March, 1958).

Single crystals of yttrium iron garnet (YIG) exhibit the narrowest resonant line of all known ferromagnetic materials, being as low as 2.3 Oe for the full width at half height for polished spheres at 9300 Mc/s. Ferromagnetic resonance on polished YIG disks was observed at frequencies as low as 44 Mc/s , for an applied d.c. field of 1000 Oe. Conversely, resonance was observed for fields as low as 300 Oe, for a frequency of 2000 Mc/s. Nonlinear effects in ferromagnetic materials can be evidenced by the excitation of unstable spin-wave modes, such as were discovered at X-band by Bloembergen and his colleagues. In their case the d.c. fields required for this subsidiary resonance were approximately one half that required for resonance of uniform precession. When measurements are made on a sphere at a frequency low enough so that $H_{res} < 8\pi M_S/3$, Suhl's theory shows that the d.c. field required for the minimum threshold of the subsidiary resonance is identical with that required for resonance of the uniform precession. In this case the critical r.f. fields required are particularly low being given in terms of the line width to an order of magnitude as $h_{crit} = \Delta H^2/4\pi M_S$. Measurements were made of h_{crit}, for the subsidiary resonance as a function of frequency for polished single crystal spheres of YIG. Based on a $4\pi M_S$ of 1725, the frequency below which coincidence of

the uniform precession and subsidiary resonances occur, is 3220 Mc/s. Below 1610 Mc/s the d.c. fields for resonance are insufficient to saturate the sphere and domains are formed. Values are given for h_{crit}, spin-wave angle θ, and spin-wave number k for frequencies of 1610 to 3220 Mc/s. At 2200 Mc/s a minimum h_{crit} occurs. At this frequency h_{crit} = 2.0 millioersted, the power incident on the cavity is 20 microwatt and the power absorbed by the sample is of the order of a microwatt. The experimental results are discussed in terms of Suhl's theory.

538.114

399. MAGNETOCRYSTALLINE ANISOTROPY OF Mg-Fe FERRITES: TEMPERATURE DEPENDENCE, IONIC DISTRIBUTION EFFECTS, AND THE CRYSTALLINE FIELD MODEL.
V.J.Folen and G.T.Rado.
J. appl. Phys., Vol. 29, No. 3, 438-40 (March, 1958).

The magnetocrystalline anisotropy constant (K_1) and saturation magnetization (M_S) of magnesium-iron ferrite monocrystals containing 6 to 50 mole % magnetite were measured as a function of temperature (T) and ionic distribution. For crystals containing 6 to 25 mole % magnetite, K_1 was found to vary more rapidly with temperature when the ionic distribution in a crystal corresponds to a relatively high M_S than when it corresponds to a relatively low Ms in the same crystal. The observed changes in K_1 resulting from alterations of the ionic distribution are shown to be consistent with a phenomenological one-ion anisotropy model. On this basis, the measurements yield a positive anisotropy for a ferric ion in a tetrahedral site (A) and a negative anisotropy for this ion in an octahedral site (B). Finally, the data obtained on one Mg-Fe ferrite crystal (containing 6 mole % magnetite) were used in the Yosida–Tachiki anisotropy theory. The ferric ion cubic crystalline field splitting parameters a_A and a_B occurring in this theory were determined for two different states of ionic distribution in the crystal. It was found that $a_A = -0.0092$ cm^{-1} and $a_B = +0.0232$ cm^{-1} for the state corresponding to a relatively high M_S, and $a_A = -0.0135$ cm^{-1} and $a_B = +0.0250$ cm^{-1} for the state corresponding to a relatively low M_S. The theoretical anisotropy curves obtained by using these a value are in very good agreement with experiment. Furthermore, the a_B values agree with $a_B = +0.0205$ cm^{-1} determined by Low from paramagnetic resonance measurements on ferric ions in MgO.

538.114

400. ORIGIN OF MAGNETIC ANISOTROPY IN $Co_xFe_{3-x}O_4$.
J.C.Slonczewski.
J. appl. Phys., Vol. 29, No. 3, 448-9 (March, 1958).

A model is proposed to explain the large part of the ferromagnetic anisotropy energy of $Co_xFe_{3-x}O_4$ (where x is small) which is caused by the presence of Co^{2+}. The residual orbital angular momentum $\alpha(\sim 1)$ of Co^{2+} is constrained by the crystal field to lie parallel to the axis of threefold symmetry. Spin-orbit energy $\lambda \mathbf{L}\cdot\mathbf{S}$ couples the spin to this axis, accounting for the anisotropy energy. By fitting the theory to experimental anisotropy data, one finds that $|\alpha\lambda| = 132$ cm^{-1}. The assumption that cations are mobile at higher temperatures leads to an explanation of the anisotropy induced by magnetic annealing.

538.114

401. THEORY OF MAGNETOSTRICTION AND g FACTOR IN FERRITES. N.Tsuya.
J. appl. Phys., Vol. 29, No. 3, 449-51 (March, 1958).

A quantum mechanical theory based upon the Heitler–London approximation is developed to explain the spatial variation of magnetostriction and g factor in ferrites. As a first step, the electronic wave-functions of cations of transition elements in the crystal field were found, taking into account the crystal structure of ferrites. The g factors of various cations in ferrites were determined by a method similar to that of Abragam and Pryce, and g factors thus found were related to those of ferrimagnetic resonance absorption by the use of the theory of Wangsness and the author. The magnetostriction was obtained by the perturbation method and it was concluded that there are four mechanisms predominant among those giving rise to magnetostriction. They are (1) the interplay of spin–orbit interaction with the strain potential, (2) classical dipolar interaction, (3) the interplay of anisotropic exchange interaction with the strain potential, and (4) the interplay of the potential with the intra-spin–spin interaction. Other mechanisms were estimated to be ineffective. The predominant mechanisms in Ni ferrite are (1) and (2); in Co ferrite, (1); in magnetite, (1), (2), and (4). In annealed Mn ferrite and Cu ferrite, the mechanism (2) is most effective. In quenched Cu ferrite, both mechanisms (2) and (3) are the most important.

538.114

402. EXCHANGE ANISOTROPY IN THE IRON–IRON OXIDE SYSTEM. W.H.Meiklejohn.
J. appl. Phys., Vol. 29, No. 3, 454-5 (March, 1958).

Exchange anisotropy is the result of a magnetic interaction between a ferromagnetic and an antiferromagnetic system. This interaction was discovered in the Co–CoO system, wherein cobalt is the ferromagnetic and cobaltous oxide is the antiferromagnetic system. The material consisted of fine particles (~ 200 A) of cobalt which had a coherent cobaltous oxide film. Above the Néel temperature where the CoO is the paramagnetic state the material had the expected behaviour of a ferromagnetic. Below the Néel temperature the interaction between the ferromagnetic cobalt and the antiferromagnetic cobaltous oxide resulted in a displaced hysteresis loop and a nonvanishing value of the rotational hysteresis for applied magnetic fields greater than $2K/I_S$. Further investigation of the temperature dependence of this system has shown that the high field ($H > 2K/I_S$) rotational hysteresis vanishes precisely at the Néel temperature of cobaltous oxide. Work on the Fe–FeO system shows a nonvanishing value of rotational hysteresis for temperatures below the Néel temperature of FeO and for magnetic fields greater than $2K/I_S$ for iron. The temperature dependence of this high field rotational hysteresis shows that it vanishes at precisely the Néel temperature of FeO.

538.114

403. RIGOROUS APPROACH TO THE THEORY OF FERROMAGNETIC MICROSTRUCTURE. W.F.Brown, Jr.
J. appl. Phys., Vol. 29, No. 3, 470-1 (March, 1958).

Current "domain" theory relies heavily on Bloch walls and the Landau–Lifshitz method of assembling them. A rigorous attack on the same problem leads to a nonlinear boundary-value problem; with electronic computers available, this problem is now less formidable than when it was first formulated and numerical calculations were carried out for an infinite cylinder that reverses its magnetization by "magnetization curling". The conditions under which this process occurs can be determined by means of a linear theory, similar to the theory of elastic stability, developed independently by the author and by Frei, Shtrikman, and Treves. To follow the process beyond its initial stages, a nonlinear differential equation must be integrated by numerical methods. The calculations show that the only stable states are ones of uniform positive or negative longitudinal magnetization; the transition between them occurs in a single jump, and only during the jump is the magnetization nonuniform. Thus a particle with no stable states other than "single-domain" ones may be "multidomain" during transitions. The results suggest that stable nonuniform states will be found in a finite body, and even in an infinite cylinder if imperfections are present.

538.114 : 621.318.12

404. MODEL FOR NONLINEAR FLUX REVERSALS OF SQUARE-LOOP POLYCRYSTALLINE MAGNETIC CORES.
M.K.Haynes.
J. appl. Phys., Vol. 29, No. 3, 472-4 (March, 1958).

The theory of the reversal waveforms of polycrystalline magnetic cores proposed by Goodenough is based on the growth of ellipsoidal domains of reverse magnetization which originate from nucleating centres at grain boundaries. The present model extends this theory with the assumption that the nucleating centres are randomly distributed throughout the core volume. Radial field variations are neglected. The rate of change of reversed magnetization area of the irreversibly moving and colliding walls is calculated as a function of their position, starting from a Poisson distribution of nucleating centres, and then converted to a function of flux. The equation derived for rate of flux change is

$$\frac{dx}{dt} = \frac{4.82}{S_W}(H-H_0)(1-x)\left(-\ln\frac{1-x}{2}\right)^{2/3},$$

where S_W is the switching coefficient, H_0 is the threshold field, H is the applied field, and x is the ratio of flux density to retentivity. This nonlinear differential equation is solved for the simple case of constant current drive. For more complicated circuit conditions, solutions of the core equations require numerical methods. Programmes have been written for the I.B.M. Type 704 D.P.M. to calculate the behaviour of circuits containing many such cores interacting and switching together. Results obtained check reasonably well with experimental evidence.

538.114

405. FERROMAGNETISM. C.Kittel.
Nuovo Cimento Suppl., Vol. 6, No. 3, 895-922 (1957).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.114

406. ANTIFERROMAGNETISM. C.J.Gorter.
Nuovo Cimento Suppl., Vol. 6, No. 3, 923-41 (1957).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.114

407. METAMAGNETICS OR SUBSTANCES ANTIFERROMAGNETIC AT THRESHOLD FIELD. L.Néel.
Nuovo Cimento Suppl., Vol. 6, No. 3, 942-60 (1957). In French.
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.114 : 539.12

408. CRITICAL SCATTERING OF NEUTRONS FROM FERROMAGNETS. W.Marshall.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1183-5 (1957).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.114

409. THE VAN VLECK MODEL OF FERROMAGNETISM. W.Marshall.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1186-7 (1957).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.114

410. STATISTICAL THEORY OF FERRO- AND ANTIFERROMAGNETISM. J.Van Kranendonk.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1190-1 (1957).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.114 : 539.2

411. INTERACTION OF SPIN WAVES AND ULTRASONIC WAVES IN FERROMAGNETIC CRYSTALS. C.Kittel.
Phys. Rev., Vol. 110, No. 4, 836-41 (May 15, 1958).
A field-theoretical treatment is given of the magneto-elastic coupling of magnons and phonons in a ferromagnetic crystal. The effects of the coupling are large when the wavelengths and frequencies of the two fields are equal. If the two transverse phonon states of a given wave vector are degenerate, then the rotatory dispersion of the phonons will be large. The possibility exists of creating non-reciprocal acoustic elements, such as acoustic gyrators. At simultaneous resonance the phonon attenuation is expected to be large. The possibility of magnetostrictive transducers at microwave frequencies is discussed. A calculation is given of the damping by eddy currents of spin waves in a metal.

538.114

412. OCTAHEDRAL COMPLEXES. I. MAGNETIC SUSCEPTIBILITIES IN THE FIRST TRANSITION SERIES. J.S.Griffith.
Trans Faraday Soc., Vol. 54, Pt 8, 1109-16 (Aug., 1958).
General formulae for matrix elements in octahedral complexes are given and applied to the calculation of spin–orbit coupling energies. A structural isomorphism is established between $(dt_{2g})^n$ and p^n configurations and used to give a short derivation of Kotani's formulae for susceptibilities of low-spin d^n complexes. The method is then extended to cover high-spin complexes and formulae are given for their susceptibilities. Agreement with experimental data is fairly good.

538.12

413. THE MAGNETIC FIELDS OF A FERRITE ELLIPSOID. R.A.Hurd.
Canad. J. Phys., Vol. 36, No. 8, 1072-83 (Aug., 1958).
Approximate expressions are found for the internal and the adjacent external magnetic fields of a small ferrite ellipsoid under plane-wave excitation. Consideration is given to the variation of apparent susceptibility with the size of the ferrite.

538.12

414. THE PRODUCTION OF VERY UNIFORM MAGNETIC FIELDS. E.M.Purcell.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1234 (1957).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.122.08 : 537.311.33

415. A NEW METHOD OF MEASURING MAGNETIC FIELD STRENGTH. G.E.Pikus and O.V.Sorokin.
Zh. tekh. Fiz., Vol. 27, No. 11, 2647-51 (1957). In Russian.
The new method presented is based on the effect of the variation of the concentration of current carriers in a thin semiconducting plate through which current passes, in a magnetic field. The given theory shows that the method may serve for measuring fields from 5×10^3 to 10^{-5} oersted, provided the relation between the voltage measured and the magnetic field strength is linear.
Electrical Research Association

538.13

416. CALCULATION OF THE INDUCED MAGNETIC MOMENT OF AN OBLATE FERROMAGNETIC ELLIPSOID OF REVOLUTION IN AN ALTERNATING MAGNETIC FIELD. L.A.Gel'bukh.
Zh. tekh. Fiz., Vol. 28, No. 3, 592-8 (1958). In Russian.
An approximate method is described. The formulae derived determine in magnitude and phase the longitudinal and transverse components of the magnetic moment of the spheroid.

538.221

417. MAGNETIC PROPERTIES OF MAGNETICALLY ANISOTROPIC SPECIMENS COMPOSED OF FERROMAGNETIC POWDERS. I. MAGNETIZATION CURVES AND PARTICULAR CYCLES OF THE HYSTERESIS LOOP.
E.V.Shtol'ts, Ya.S.Shur and G.S.Kandaurova.
Fiz. Metallov i Metallovedenie, Vol. 5, No. 3, 412-20 (1957).
In Russian.
Experiments are described relating the magnetic properties of MnBi powder compacts to particle size. It is concluded that fine powder particles may have a single domain structure or a structure transitional between a one-domain and a multi-domain structure. A model for this transitional structure is proposed. A.F.Brown

538.221

418. MAGNETIC PROPERTIES OF MAGNETICALLY ANISOTROPIC SPECIMENS COMPOSED OF FERROMAGNETIC POWDERS. II. THE DEPENDENCE OF THE MAGNETIZATION CURVES ON THE MECHANISM OF FORMATION OF A DEMAGNETIZED STATE. Ya.S.Shur, E.V.Shtol'ts and G.S.Kandaurova.
Fiz. Metallov i Metallovedenie, Vol. 5, No. 3, 421-7 (1957).
In Russian.
For Pt I, see preceding abstract. Further experiments confirm the existence of the transition structure discovered in fine powder compacts of MnBi. A.F.Brown

538.221

419. STATIC AND DYNAMIC BEHAVIOR OF THIN PERMALLOY FILMS. D.O.Smith.
J. appl. Phys., Vol. 29, No. 3, 264-73 (March, 1958).
Thin magnetic films (~ 1000 A) evaporated on to a heated glass substrate in the presence of a d.c. magnetic field develop a uniaxial magnetic anisotropy energy of the form $E_K = K \sin^2\phi$, with ϕ measured from the deposition field. Such films promise to out-perform ferrite cores in digital-computer memory-systems by several orders of magnitude. A detailed static and dynamic theory based on the above anisotropy energy and the Landau–Lifshits dynamical equation is presented. The static theory contains the unique feature of the coercive force parallel to the easy axis being dependent on a field in the plane of the film and perpendicular to the easy axis. Experimental verification of the theory is given. The dynamic theory considers both steady-state and pulse response. The steady-state solution is well-known; the pulse solution must take very careful account of all the important torques acting in a switching experiment, and numerical results are obtained by the use of a digital computer. Experimentally, steady-state resonance was measured from 100 to 10 000 Mc/s and pulse switching down to 3 mμsec. Both types of experiment are in good agreement with each other and with the theory.

538.221

420. FLUX REVERSAL IN THIN FILMS OF 82% Ni, 18% Fe. C.D.Olson and A.V.Pohm.
J. appl. Phys., Vol. 29, No. 3, 274-82 (March, 1958).
The magnetization reversal process of iron–nickel films (nominally 82% Ni-18% Fe) deposited in the presence of a magnetic field to a thickness of about 1000 to 4000 A were examined by the application of appropriate fields. Experimental results indicate that at least two different magnetization reversal mechanisms are effective. The first, characterized by relatively long remagnetization periods, involves domain-wall movement; the second, characterized

by relatively short remagnetization periods, is consistent with the rotation of the magnetization in the plane of the film. The threshold for the rotational process is altered by the application of transverse magnetic field in a manner consistent with a simple energy model.

538.221

421. DOMAIN-WALL STRUCTURE IN PERMALLOY FILMS. E.E.Huber, Jr, D.O.Smith and J.B.Goodenough.
J. appl. Phys., Vol. 29, No. 3, 294-5 (March, 1958).

Domain-wall structure in Permalloy films in the thickness range from 25 to 2000 A was studied by the Bitter technique. A new type of 180° wall was observed: the main wall is cut at regular intervals by short, right-angle "cross ties" which terminate in free, single ends. The cross-tie period and length are dependent on film thickness, each becoming shorter with decreasing thickness. These patterns can be understood in terms of a new model for the structure of domain walls in thin films of low-anisotropy material. In the conventional model the atomic moments within the wall rotate about an axis perpendicular to the wall. In a thin film such a configuration leads to a large energy contribution from the large demagnetization factor normal to the film. In the new model, the axis of rotation is itself thought to rotate about the axis of the wall to give a "corkscrew" configuration of spins and a large decrease in associated magnetostatic energy. Of several experiments which were performed which support this model, one is briefly described.

538.221

422. LOW-TEMPERATURE SPIN-WAVE RESONANCE AT 3000 AND 4000 Mc/SEC IN A PERMALLOY HAVING NEARLY ZERO MAGNETOCRYSTALLINE ANISOTROPY.
J.R.Weertman and G.T.Rado.
J. appl. Phys., Vol. 29, No. 3, 328-9 (March, 1958).

The observation of spin-wave resonance in Permalloy samples of extremely low anisotropy was extended to liquid nitrogen temperature. Measurements at both room and liquid nitrogen temperature were carried out at 3000 and at 4000 Mc/s. At room temperature the complete experimental resonance curve can be explained at both frequencies on the basis of the spin-wave resonance theory of Ament and Rado by using an average exchange stiffness constant, A, of $(3.3 \pm 0.5) \times 10^{-6}$ erg/cm and a g factor of 2.06 ± 0.01. The agreement between experiment and theory would be destroyed if a Landau–Lifshitz or Bloch damping term were included. The theory of Ament and Rado predicts that as the temperature is lowered the exchange broadening of the resonance line increases and the resonance field decreases. Both effects were observed qualitatively but neither is as large as would be expected from the theory. It was found that at a given temperature the plot of the imaginary versus real part of the equivalent permeability at 3000 Mc/s differs only by a scale factor from the corresponding plot at 4000 Mc/s. At room temperature the above frequency increase causes a decrease in the permeabilities of 30% from the corresponding values at 3000 Mc/s, as compared to a predicted 15% decrease. The discrepancy between theory and experiment at the low temperature is about the same at one frequency as at the other. Since the corresponding resonance fields differ by a factor of two, any effects due to incomplete saturation seem to be ruled out.

538.221 : 621.318.12

423. RESONANCE MEASUREMENTS ON NICKEL-COBALT FERRITES AS A FUNCTION OF TEMPERATURE AND ON NICKEL FERRITE-ALUMINATES. J.E.Pippin and C.L.Hogan.
I.R.E. Trans Microwave Theory and Tech., Vol. MTT-6, No. 1, 77-82 (Jan., 1958).

The variation of line width (ΔH) and effective g factor (g_{eff}) with cobalt content and with temperature is studied in a series of ferrites of composition $Ni_{1-\alpha}Co_{\alpha}Mn_{0.02}Fe_{1.9}O_{4\pm}$. Here α lies between 0 and 0.09; temperatures range from 20°C to 340°C. A minimum in ΔH is observed at $\alpha = 0.027$; g_{eff} decreases with increasing α. The temperature dependence of each is qualitatively that which would be expected on the basis of the temperature dependence of the anisotropy of the mixed ferrite. Above room temperature ΔH and g_{eff} increase or decrease, depending on the cobalt content. It is also shown that the shape of the resonance line is determined by the sign of the anisotropy constant. For negative K_1 the line is steeper on the low-field side of resonance — for positive K_1 it is steeper on the high-field side. Resonance data are presented on several nickel-cobalt ferrite-aluminates, of composition $Ni_{1-\alpha}Co_{\alpha}Mn_{0.02}Fe_{2-t}Al_tO_{4\pm}$, with α varying from 0 to 0.025 for t = 0.3, 0.4, 0.5, and 0.6. The reduction of ΔH and g_{eff} expected from anisotropy considerations is observed.

538.221 : 621.318.124

424. FERRIMAGNETIC RESONANCE IN SOME POLYCRYSTALLINE RARE EARTH GARNETS.
G.P.Rodrigue, J.E.Pippin, W.P.Wolf and C.L.Hogan.
I.R.E. Trans Microwave Theory and Tech., Vol. MTT-6, No. 1, 83-91 (Jan., 1958).

Ferrimagnetic resonance measurements were carried out on a series of polycrystalline garnets of composition $5Fe_2O_3 \cdot 3M_2O_3$ with M = Y, Sm, Gd, Dy, Ho, Er, and Yb. These measurements were made over a temperature range from 20°C to the Curie points (approximately 280°C). The variations of line widths and effective g values over this temperature range are reported. Y, Yb, and Sm garnets have g values of approximately 2.0 at room temperature while those of Dy, Ho, and Er are appreciably less than 2.0. High-density yttrium garnet has a line width of approximately 50 Oe at room temperature; line widths of other members of this series were found to vary from 400 to greater than 3000 Oe. The effective g value and line width of the gadolinium garnet tend to very high values as its compensation point (17°C) is approached. The narrow line width of the yttrium garnet is found to depend strongly on the density of the sample. When the density decreases from 96% to approximately 92% of the theoretical value, the line width increases from 50 to about 150 Oe. Several technical applications in which these materials might be particularly advantageous are discussed briefly.

538.221

425. SOME PROPERTIES OF QUENCHED MAGNESIUM FERRITES. D.J.Epstein and B.Frackiewicz.
J. appl. Phys., Vol. 29, No. 3, 376-7 (March, 1958).

A study was made of the magnetic properties of the system of quenched magnesium ferrites

$$(Mg_x^{II}Fe_{1-x}^{III})(Mg_{1-x}^{II}Fe_{1-x}^{III})O_4,$$

where x, the fraction of magnesium ions in tetrahedral sites, varies from 0.14 to 0.26. Included among the properties examined are: saturation moment, Curie point, initial permeability, and coercive force. A limited study of the kinetics of the cation redistribution was also made. Samples quenched from 100°C and then tempered at 600°C require somewhat less than 16 hours to attain an equilibrium cation distribution at the latter temperature. The approach to equilibrium is consistent with a model in which the rate of approach is proportional to $\exp(-\theta_0' + \theta_1'x)/T$, where θ_0' and θ_1' are activation constants.

538.221

426. IONIC VALENCES IN MANGANESE-IRON SPINELS. A.H.Eschenfelder.
J. appl. Phys., Vol. 29, No. 3, 378-80 (March, 1958).

Because both manganese and iron assume multiple valences in oxide structures, it is possible to fabricate spinels over a continuous range of composition from Mn_3O_4 to Fe_3O_4. Magnetic-moment data for samples fabricated within this range are reported and an interpretation of the data in terms of the distribution of ions of manganese and iron is presented. The data agree with previous indications that manganese ferrite, $MnFe_2O_4$, is an almost completely normal spinel with Mn^{2+} on A sites and Fe^{3+} on B sites. In addition, the usual assumption that excess iron replaces manganese as Fe^{2+} on B sites is substantiated. However, the data are not compatible with the previously held assumption that Fe^{3+} is replaced by excess manganese as Mn^{3+}. Instead, the variation of magnetic moments and Curie temperatures with composition is interpreted in terms of a model in which excess manganese replaces Fe^{3+} as Mn^{4+} and an equal amount of iron is converted to Fe^{2+}. When the manganese content gets so high that all the iron is Fe^{2+} (Mn_2FeO_4), manganese then replaces the iron as Mn^{3+} and reconverts an equal amount of Mn^{4+} to Mn^{3+}, and the Mn^{3+}, because of its tetragonal nature, introduces spinel twinning. It is proposed that the $Mn^{4+}-Fe^{2+}$ pair in octahedral coordination is stabilized with respect to a $Mn^{3+}-Fe^{3+}$ pair because of the interaction of the manganese orbitals with the 2p orbitals of the surrounding oxygen anions.

538.221

427. SUBSTITUTION FOR IRON IN FERRIMAGNETIC YTTRIUM-IRON GARNET. M.A.Gilleo and S.Geller.
J. appl. Phys., Vol. 29, No. 3, 380-1 (March, 1958).

In yttrium-iron garnet, iron may be entirely replaced by aluminium and gallium; chromium, scandium, and indium may be substituted for iron to a limited extent. Substitution proceeds on a steric basis for the nonmagnetic ions: Al^{3+} and Ga^{3+}, which are smaller than Fe^{3+}, preferentially occupy the smaller, tetrahedrally coordinated positions, 24(d); the Sc^{3+} and In^{3+} ions, which are larger

than Fe^{3+}, preferentially occupy the larger, octahedrally coordinated positions, 16(a). The Cr^{3+} ion, though smaller than Fe^{3+}, preferentially occupies the octahedral position, presumably because of its electronic configuration. The magnetic moment initially increases with octahedral substitution and decreases with tetrahedral substitution. The Curie temperature is decreased by the substitution of nonmagnetic ions for iron as a consequence of the decrease in the number of $Fe^{3+}-O^{2-}-Fe^{3+}$ interactions.

538.221 : 548.736.5

428. SOME MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF THE SYSTEM $LaMn_{1-x}Ni_xO_{3+\lambda}$.
A.Wold, R.J.Arnott and J.B.Goodenough.
J. appl. Phys., Vol. 29, No. 3, 387-9 (March, 1958).

The system $LaMn_{1-x}Ni_xO_{3+\lambda}$ was prepared under varying conditions for the entire range of compositions $0 \leq x \leq 1$. The saturation magnetization, lattice parameters, and chemical analysis were measured for each sample. The origin of discrepancies in the literature on the crystal structure of $LaMnO_3$ is shown to be due to different preparation procedures which result in the presence of differing amounts of Mn^{4+}: the lattice symmetry changes from orthorhombic to rhombohedral as the Mn^{4+} concentration exceeds 18% of the total manganese. The system is ferromagnetic with magnetization only slightly less than the spin-only value over the compositional range $0.2 \leq x \leq 0.5$: a ferromagnetic Ni^{3+}-Mn^{3+} interaction is indicated. The system remains orthorhombic throughout the range $0 \leq x < 0.5$; it shows an increasing distortion to an apparently monoclinic symmetry in the range $0.5 < x \leq 0.8$. $LaNiO_3$ is rhombohedral at room temperature. The lattice symmetry is compatible with Ni^{3+} in a low-spin state: this is also in accord with the magnetization values. Qualitative concepts used to interpret the system (La,Ca)MnO_3 are applied to interpret the magnetic and crystallographic properties of this system as well as the magnetic properties of some rhombohedral perovskite-type systems rich in Mn^{3+} ions.

538.221 : 548.74

429. ANTIFERROMAGNETIC STRUCTURES OF MnS_2, $MnSe_2$, AND $MnTe_2$. L.M.Corliss, N.Elliott and J.M.Hastings.
J. appl. Phys., Vol. 29, No. 3, 391-2 (March, 1958).

The antiferromagnetic structures were obtained by neutron diffraction. The disulphide exhibits ordering of the "third" kind, the ditelluride, ordering of the "first" kind, and the diselenide, an arrangement which is intermediate between the two. The structures are discussed from the viewpoint of indirect exchange.

538.221

430. MICROWAVE PROPERTIES OF POLYCRYSTALLINE RARE EARTH GARNETS. M.H.Sirvetz and J.E.Zneimer.
J. appl. Phys., Vol. 29, No. 3, 431-3 (March, 1958).

A number of garnets including yttrium garnet, $Y_3Fe_5O_{12}$, and mixed garnets of the forms $(Y_{1-\alpha}Sm_\alpha)_3Fe_5O_{12}$ and $(Y_{1-\beta}Gd_\beta)_3Fe_5O_{12}$ were prepared. X-band ferromagnetic resonance and saturation magnetization were measured as a function of temperature. At room temperature samarium substitution for yttrium produces an approximately linear increase of line-width with samarium content with practically no change in magnetization. Gadolinium substitution, on the other hand, has a much smaller effect on line-width but produces an approximately linear decrease in saturation magnetization. Possible microwave application of these materials are discussed.

538.221

431. FERRIMAGNETIC RESONANCE IN SINGLE CRYSTALS OF RARE EARTH GARNET MATERIALS.
R.V.Jones, G.P.Rodrigue and W.P.Wolf.
J. appl. Phys., Vol. 29, No. 3, 434-5 (March, 1958).

The preliminary results of a study of the ferrimagnetic resonance properties of single crystals of rare earth iron garnet containing samarium, gadolinium, dysprosium, holmium, erbium, and ytterbium are presented. The measurements were conducted in the temperature region from 77° K to 550° K at microwave frequencies in the X band. The effective g values and line widths are consistent with the previously reported measurements on polycrystalline samples. In this temperature region the anisotropy energy of the Sm, Gd, Er, and Yb crystals can be represented by the usual cubic form with a negative first order term. The line widths exhibit a large anisotropy which increases with decreasing temperature.

538.221 : 548.736.4

432. CRYSTALLOGRAPHIC AND MAGNETIC STUDIES OF THE SYSTEM $(NiFe_2O_4)_{1-x}+(NiMn_2O_4)_x$. P.K.Baltzer and J.G.White.
J. appl. Phys., Vol. 29, No. 3, 445-7 (March, 1958).

The system $(NiFe_2O_4)_{1-x}+(NiMn_2O_4)_x$ was selected to study the role of the Mn^{3+} ion in determining the crystallographic and magnetic properties of spinels. The ionic distribution was investigated by means of X-ray diffraction. A cubic spinel structure is obtained throughout the system, the lattice parameter increasing monotonically with x from 8.34 to 8.39 A. It is found that in the range $0 \leq x \leq 0.5$ that manganese progressively replaces iron on the six-coordinated sites. Whereas, in the range $0.5 \leq x \leq 1$, the manganese progressively replaces iron on the four-coordinated sites. Therefore, manganese is not able to displace nickel from the six-coordinated sites and $NiMn_2O_4$ is a cubic inverse spinel. These results are consistent with the thesis that the tetragonal distortions of $ZnMn_2O_4$, Mn_3O_4, $MgMn_2O_4$, and $Li_{0.5}Mn_{2.5}O_4$ are because of the six-coordinated sites in these compounds essentially all being occupied by manganese ions. Magnetostriction measurements were made as a function of applied field to determine the sign and order of magnitude of the magnetic anisotropy of the polycrystalline samples. The magnetic anisotropy is found to pass through zero with increasing x, becoming highly positive ($K \cong +10^5$ ergs/cm^3) at $x = 0.5$. Heretofore only the Co^{2+} ion has been found to produce a positive anisotropy in the spinel structure. Magnetic moment measurements indicate that all of the manganese is trivalent in the range $0 \leq x \leq 0.5$ However, magnetic moment measurements over the range $0.5 \leq x \leq 1$ indicate that at $x = 1$, $NiMn_2O_4$, the manganese is divalent and quadravalent on the four- and six-coordinated sites respectively. $NiMn_2O_4$ appears to become ferrimagnetic at approximately 100° K.

538.221

433. TEMPERATURE DEPENDENCE OF MICROWAVE PERMEABILITIES FOR POLYCRYSTALLINE FERRITE AND GARNET MATERIALS. J.Nemarich and J.C.Cacheris.
J. appl. Phys., Vol. 29, No. 3, 474-6 (March, 1958).

Measurements of the microwave permeabilities $\mu_{||}$ and $\mu_\perp = (\mu^2 - K^2)/\mu$ were made at a frequency of about 9200 Mc/s using a cavity perturbation technique. Samples in the form of thin slabs were used. Both the static magnetic field and the temperature were varied. The temperature ranged from 25° to 150° C and the internal magnetic fields were varied from zero to 1500 Oe. A general qualitative agreement between theory and experiment is obtained for one of the ferrite materials. Both $\mu_\perp$ and $\mu_{||}$ were found to increase with increasing temperature for the range measured.

538.221

434. MAGNETIC PROPERTIES OF DILUTE MAGNETIC ALLOYS AND OF THE RARE EARTH METALS. G.W.Pratt, Jr.
J. appl. Phys., Vol. 29, No. 3, 520-1 (March, 1958).

Dilute alloys of paramagnetic atoms in Cu or the noble metals were found to exhibit ferromagnetism as well as antiferromagnetism. This is of particular interest because the origin of the magnetic behaviour cannot lie in the customary Heisenberg exchange interaction between nearest neighbours because of the large separation between the paramagnetic atoms in dilute alloys. A similar situation exists in the rare earths where nearest neighbour 4f–4f direct exchange is negligible. The spin coupling can be explained by taking account of the direct exchange interaction between the paramagnetic atoms and the conduction electrons and by super-exchange. To describe the super-exchange coupling it is necessary to know the energy levels of the paramagnetic atom in the solid. The results of a Hartree–Fock analysis of this problem are briefly discussed. A generalization of a previous molecular field treatment is also given.

538.221 : 538.662

435. PYROMAGNETIC EFFECT: A METHOD FOR DETERMINING CURIE POINTS. A.G.Chynoweth.
J. appl. Phys., Vol. 29, No. 3, 563-5 (March, 1958).

A dynamic technique was developed for studying the pyromagnetic effect (the change in the intensity of magnetization I with temperature T). The thermal transients produced in a crystal of gadolinium iron garnet when subjected to brief, intense, flashes of light, result in transient changes in the intensity of magnetization. The magnitude of the signal picked up by the detector coil is determined by the pyromagnetic coefficient (dI/dT), and the rate of change of the temperature. No externally applied magnetic field is necessary to obtain these signals and, furthermore, the net state of magnetization of the crystal is determined nondestructively. As (dI/dT) possesses a very sharp peak at the Curie point, the latter can be determined simply and with some precision; the actual temperature change produced in the crystal by the light can be kept to a small fraction of a degree. The Curie point for gadolinium iron garnet was found to be 564 ± 3° K. The technique may prove to be useful for studying the behaviour of (dI/dT) at low temperatures.

538.221 : 548.3

436. RELATION BETWEEN CRYSTALLITE ORIENTATION AND MAGNETIC PROPERTIES OF ELONGATED SINGLE-DOMAIN IRON PARTICLES. F.E.Luborsky, E.F.Fullam and D.S.Hallgren.
J. appl. Phys., Vol. 29, No. 6, 989-93 (June, 1958).

Analysis by selected area electron diffraction of aligned elongated single-domain iron particles, each about 150 A by 500 A, indicates that the long axis of the particle is coincident with the [111] crystallographic direction. Diffuse diffraction rings and elongated spots were attributed to a considerable degree of random crystallite orientation. These results confirm predictions based on particle morphology and on the temperature coefficient of coercive force of iron and iron–cobalt alloy particles. This [111] orientation offers an explanation for the increase in coercive force with increase in temperature observed for single domain iron–cobalt alloy particles and suggests a related explanation for the Alnico type alloys.

538.221

437. COERCIVE FORCE OF IRON OXIDE MICROPOWDERS AT LOW TEMPERATURES. A.H.Morrish and L.A.K.Watt.
J. appl. Phys., Vol. 29, No. 7, 1029-33 (July, 1958).

The coercive force of some magnetite and gamma-ferric oxide micropowders was measured in the temperature range from 77° to 300°K. Some of the powders contained essentially only single-domain non-circular particles, others contained only multi-domain particles. For the former, the results are consistent with an interpretation based on the usual relationship between coercive force and the anisotropies; for the latter with an interpretation based on the variation of the crystalline anisotropy constant with temperature. In addition, a new memory effect was observed for the multi-domain magnetite powders. If a sample was placed in some state of magnetization below the transition temperature, warmed to room temperature and then recooled, the measured value of the coercive force depended on this original state.

538.221

438. TEMPERATURE DEPENDENCE OF MAGNETIC PROPERTIES OF SILICON–IRON. C.W.Chen.
J. appl. Phys., Vol. 29, No. 9, 1337-43 (Sept., 1958).

Permeability, coercive force, remanence, hysteresis and core losses of a 3% singly oriented silicon–iron alloy was measured in the temperature range from 30° to 700°C. Their temperature dependence is interpreted in terms of either the intrinsic properties of a ferromagnetic or domain theory. The magnetization curve is analysed on the basis of the crystallographic characteristics of the texture in the material. Domain distribution is discussed at each stage of magnetization. Application of the analysis leads to the establishment of the relationship between the temperature coefficient of permeability and the magnetization processes.

538.221 : 539.32

439. MAGNETIC AFTER EFFECT AND INTERNAL FRICTION AT HIGH TEMPERATURES IN IRON AND SOME IRON ALLOYS. A.Ferro and G.Montalenti.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1214-15 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.221

440. THE ANTIFERROMAGNETIC STATE IN THE CHROME ALUMS. J.H.Van Vleck.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1235 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.221

441. INFLUENCE OF FOREIGN IONS ON THE CRITICAL FIELD STRENGTH OF AN ANTIFERROMAGNETIC. K.F.Niessen.
Philips Res. Rep., Vol. 12, No. 4, 355-63 (Aug., 1957).

The critical field strength is calculated for an antiferromagnetic material in each of whose sub-lattices a number of original magnetic ions has been replaced by foreign magnetic ions with different magnetic moments, or simply by non-magnetic ions. The change in the critical field strength can be given by a simple formula.

538.221

442. NON-MAGNETIC IONS IN AN ANTIFERROMAGNETIC. K.F.Niessen.
Philips Res. Rep., Vol. 13, No. 4, 327-34 (Aug., 1958).

An experimental method is described for determining the distribution of a relatively small number of foreign non-magnetic ions between the two sub-lattices of an antiferromagnetic, in which they replace the same number of original magnetic ions. The influence of the foreign ions on several measurable quantities is investigated. This influence can be used to determine some specific constants of the antiferromagnetic. In the anisotropy energy, besides the usual terms, an interaction term between the two sub-lattices is taken into account. Use is made of the spontaneous magnetization, the parallel and perpendicular susceptibilities, the critical field strength and the antiferromagnetic resonance.

538.221

443. MAGNETIC SPECTRA OF MANGANESE FERRITES. S.E.Harrison, C.J.Kriessman and S.R.Pollack.
Phys. Rev., Vol. 110, No. 4, 844-9 (May 15, 1958).

The complex initial permeability of a series of polycrystalline manganese-rich manganese ferrites ($Mn_{1+x}Fe_{2-x}O_4$) was measured between 20 and 200 Mc/s. Three resonances are detected; the two lower-frequency resonances, which occur below 200 Mc/s, are associated with domain wall motion. The higher-frequency resonance, which varies between 300 and 600 Mc/s depending on the composition, allows the calculation of an effective polycrystalline anisotropy constant, K_e. Microwave resonance measurements on single crystals of the same composition give the real anisotropy constant K_1. Comparison of these two experiments show that $K_e \approx 2K_1$. Measurement of the magnetic moment indicates that in these compounds the Mn^{3+} ion assumes a value of approximately two Bohr magnetons instead of the expected four Bohr magnetons.

538.221

444. MAGNETIC STRUCTURES OF MnO, FeO, CoO, AND NiO. W.L.Roth.
Phys. Rev., Vol. 110, No. 6, 1333-41 (June 15, 1958).

The antiferromagnetic arrangement of moments in MnO, FeO, CoO, and NiO was investigated by powder neutron diffraction. The results for the four oxides are consistent with a structure in which the magnetic moments are arrayed in ferromagnetic sheets parallel to (111) planes, and the direction of magnetization in neighbouring planes is antiparallel. The observation of diffuse neutron scattering limits the precision with which the magnetization direction can be specified. If the diffuse intensity is included with the Bragg scattering, the direction of magnetization in MnO and NiO lies within the (111) plane; for CoO, the preferred direction is [117], intermediate to the (111) plane and the tetragonal axis. The magnetic axis in FeO is perpendicular to the ferromagnetic sheet.

538.221

445. NOTE ON THE MAGNETIC SUSCEPTIBILITY OF DILUTE Cu–Mn ALLOYS. A.J.Dekker.
Physica, Vol. 24, No. 8, 697-706 (Aug., 1958).

The following features of the susceptibility of these alloys are discussed: (a) the concentration dependence of the effective Curie temperature in the high temperature region; (b) the occurrence of a "gradual" antiferromagnetic transition at low temperatures; (c) the concentration dependence of the position and shape of the antiferromagnetic transition.

538.221

446. NICKEL–COPPER FERRITES WITH A NARROW RESONANCE ABSORPTION CURVE AT U.H.F.
V.A.Fabrikov, V.D.Kudryavtsev and Z.M.Gushchina.
Radiotekhnika i Elektronika, Vol. 2, No. 10, 1299-300 (1957). In Russian.

Gives details of the preparation of ferrites for use at resonant absorption at frequencies in the region of 10 Gc/s. The half-width of the resonance absorption curve for these materials is about 100-150 Oe. Microphotographs of two samples of material of different composition are shown. R.C.Glass

538.221 : 538.632 : 621.318.13 : 621.317.4

447. REMARKS ON THE MEASUREMENT OF THE HALL EFFECT IN FERROMAGNETICS.
K.M.Koch, W.Rindner and K.Strnat.
Z. Naturforsch., Vol. 13a, No. 2, 113-16 (Feb., 1958). In German.

It is pointed out that, if the magnetic field is misaligned in a Hall effect test, the magnetization vector within the specimen will deviate far more from the nominal direction (normal to the plane of the specimen) than the external field does. This can cause appreciable errors in the Hall voltage. The calculation is confirmed by experiments on nickel and on an iron alloy. K.W.Plessner

538.221

448. THE EFFECT OF HYDRAULIC PRESSURE ON THE TEMPERATURE OF ANTIFERROMAGNETIC TRANSFORMATION IN MANGANESE TELLURIDE. N.P.Grazhdankina.
Zh. éksper. teor. Fiz., Vol. 33, No. 6(12), 1524-5 (1957). In Russian.

The electrical resistance R of MnTe was measured at T = 279 to

363°K under hydraulic pressure P = 1-5200 kg/cm². R decreased with increasing P, the pressure coefficient of R varying with T between −3.5 and −0.73. Increasing P resulted also in raising the temperature of the antiferromagnetic transformation T_N (Néel point), the magnitude of the effect being $dT_N/dP = (2.0 \pm 0.4) \times 10^{-3}$. T_N calculated for P = 4400 kg/cm² from the slope of the R(T) curve was +46°C. M.H.Sloboda

538.221 : 621.318.12

449. FERROMAGNETIC RESONANCE IN SOME FERRITES AT LOW TEMPERATURES. N.I.Krivko.
Zh. tekh. Fiz., Vol. 28, No. 8, 1703-10 (1958). In Russian.

Results are reported of an experimental investigation on ferromagnetic resonance at low temperatures at a frequency of approximately 9.4 Gc/s. The materials studied included Ni—Zn and Li—Zn ferrites with different molar percentages of the constituent components. The basic parameters were g- factor and T, the relaxation time determined according to Pil'schikov's formula, from the extremes of the curves of loss and dispersion. The relaxation times were shown to have a weak temperature dependence and a value of the order of 10^{-9} sec at 4.2°K. An interesting fact was the observation of a reduction in g-factor with decreasing temperature for ferrites of the following composition: 16.7% NiO, 37.3% ZnO, 46% Fe_2O_3; 18% NiO, 42% ZnO, 40% Fe_2O_3; 20% Li_2O, 80% Fe_2O_3. An explanation for this reduction can be found on the basis of allowing for interaction between the sub-lattices in the real ferrite lattice. S.C.Dunn

538.222 : 539.27

450. PARAMAGNETIC AND NUCLEAR SCATTERING CROSS SECTIONS OF HOLMIUM SESQUIOXIDE.
W.C.Koehler, E.O.Wollan and M.K.Wilkinson.
Phys. Rev., Vol. 110, No. 1, 37-40 (April 1, 1958).

Neutron diffraction experiments on holmium oxide (Ho_2O_3) were performed to investigate the magnetic properties of trivalent holmium ion in the oxide and to measure the heretofore unknown coherent scattering cross-section of Ho. The coherent neutron scattering cross-section of Ho on Ho_2O_3 was found to be (9.1 ± 0.5) barns with amplitude of positive phase. The total nuclear scattering cross-section was estimated to be about 13 barns. The magnitude and angular dependence of the differential cross-section for paramagnetic scattering by the trivalent holmium ion in Ho_2O_3 was measured at room temperature. For small scattering angles the observed cross-section is equal, within experimental error, to that calculated for the free-ion moment, i.e. 10.6 Bohr magnetons, and the angular dependence of the differential scattering cross-section reflects the full contribution of the orbital as well as of the spin contribution to the total moment of the ion.

538.222

451. PARAMAGNETIC ELECTRON RESONANCE-INDUCTION.
E.Lutze and D.Bösnecker.
Naturwissenschaften, Vol. 45, No. 14, 332 (1958). In German.

The simultaneous observation of electron resonance absorption and induction signals at λ = 3.33 cm in $CuSO_4.5H_2O$ is reported. A.J.Manuel

538.222 : 535.345

452. PARAMAGNETIC RESONANCE AND OPTICAL INVESTIGATION OF SILICATE GLASSES AND FUSED SILICA, COLOURED BY X-RAYS. J.S. van Wieringen and A.Kats.
Philips Res. Rep., Vol. 12, No. 5, 432-54 (Oct., 1957).

Silicate glasses containing alkali oxides (or mixtures of alkali and alkaline earth oxides) were irradiated with X-rays both at room and liquid-nitrogen temperatures. Colour centres were produced whose optical and paramagnetic resonance properties were studied. All silicate glasses showed two paramagnetic resonance peaks due to two different colour centres containing electrons and holes, respectively. From the line widths at 9500 and 24 000 Mc/s it follows that both centres have a spin ½ and are in local electric fields of very low symmetry. Comparison with the optical measurements shows that the electron centre is likely to be connected with the optical absorption band between 4150 A and 4900 A, and the hole centre with the band at 3100 A. Similar measurements were made on fused silica irradiated with X-rays at room temperature. Again two paramagnetic resonance peaks were found, ascribed to electrons and holes, respectively. In the optical spectrum three absorption bands were developed. The behaviour of fused silica depends strongly on its water content. After irradiation the samples containing water showed only the resonance peak of the electron centre and the optical absorption band at 2150 A; the hole peak and the other two bands were absent or extremely weak.

538.222

453. MAGNETIC ANISOTROPY IN SINGLE-CRYSTAL FERRIC AMMONIUM ALUM BELOW ITS MAGNETIC CRITICAL POINT.
C.W.Dempesy and R.C.Sapp.
Phys. Rev., Vol. 110, No. 2, 327-31 (April 15, 1958).

The adiabatic paramagnetic susceptibility of single crystals of ferric ammonium alum was determined as a function of entropy and applied field below 0.1°K. Two methods of measurement were employed: in addition to a standard ballistic bridge technique, a moving-coil device was developed to yield static values. A ballistic galvanometer of period 4.6 sec was used in both circuits. The two single crystals utilized were both shaped as 1.6 :1 prolate ellipsoids, one with major dimension along a cubic axis (1,0,0) and the other with major dimension isogonal to the cubic axes (1,1,1). The susceptibility v. entropy results for the single crystals obtained by the ballistic bridge do not display any striking differences from those observed for powdered samples, but the moving-coil measurements indicate that the region of nearly constant susceptibility below the magnetic critical point extends to even lower entropies. The differential susceptibility determined by the ballistic bridge in the presence of applied fields up to 300 gauss reveals the presence of magnetic anisotropy. The (1,1,1) data display a weak hump near 120 gauss, in contrast to the (1,0,0) results which reveal no hump and are consistently lower in magnitude. No adequate theoretical explanation of the ordering phenomena in ferric alum is as yet available.

538.222

454. HIGH FREQUENCY SUSCEPTIBILITIES OF SOME PARAMAGNETIC ALUMS AT LIQUID HYDROGEN TEMPERATURES.
J.C.Verstelle, G.W.J.Drewes and C.J.Gorter.
Physica, Vol. 24, No. 8, 632-8 (Aug., 1958).

The susceptibilities of chromium and iron alum, as well as some samples diluted by aluminum, were studied at liquid hydrogen temperatures between 1 and 20 Mc/s as functions of a parallel magnetic field. At these frequencies and temperature the spin—lattice relaxation plays no role, and the phenomena observed were not found to vary with temperature. Anomalies were observed which were particularly marked in the diluted samples where the electric splittings are large compared with magnetic interactions. At the higher frequencies the susceptibility has maxima at zero field and at a few hundred oersted. A tentative explanation of the maxima and relaxations is presented, the maximum at a few hundred oersted being attributed to a flip-flop process dealing with two neighbouring ions.

538.222 : 537.311.31 : 536.413.2

455. THE MAGNETIC SUSCEPTIBILITIES OF ALLOYS OF CERIUM WITH THORIUM. L.F.Bates and M.M.Newmann.
Proc. Phys. Soc., Vol. 72, Pt 3, 345-52 (Sept., 1958).

The paramagnetic susceptibilities of 90, 71, 60, 42, 20, 10 and 5 atomic per cent cerium in thorium alloys were measured over the temperature range 90°K to 700°K. The temperature dependence of the resistivity of 90, 60, 40, 20 and 5 atomic per cent cerium—thorium alloys was investigated over the range 90°K to 293°K. The thermal expansion of the 60% alloy was measured over this temperature range. All the alloys exhibit a sharp decrease in susceptibility at low temperatures. This has been attributed to the excitation of some of the 4f electrons of the cerium atoms into the conduction band at these temperature, and the resistivity and expansion results support this hypothesis. Above room temperature the susceptibilities of all the alloys obey a Curie—Weiss law, $\chi = C/(T-\theta)$, over at least part of the temperature range. The effective magnetic moments per cerium atom, calculated from the Curie constants C increased with decreasing cerium content. A model is proposed in which coupling between the cerium f electron and the conduction electrons causes polarization of the latter in the neighbourhood of the cerium atoms. The apparent increase in p_{eff} is attributed to this induced moment.

538.245

456. MAGNETIZATION PROCESSES IN HEAT-TREATED SINGLE CRYSTAL COBALT FERRITE. S.Foner and J.O.Artman.
J. appl. Phys., Vol. 29, No. 3, 443-4 (March, 1958).

The results of a series of magnetization measurements, ranging from 4.2°K to 300°K, on a heat-treated single crystal of cobalt ferrite are summarized. A simple domain picture accounts for the results and agrees with many related experimental observations. Derived values of cubic anisotropy and induced uniaxial anisotropy are presented. Low temperature hysteresis and remanence observations are also described. A mechanism which could account for the unusual magneto-thermally induced uniaxial behaviour is outlined briefly.

538.245

457. MAGNETIC DOMAIN PATTERNS ON IRON WHISKERS. R.V.Coleman and G.G.Scott.
J. appl. Phys., Vol. 29, No. 3, 526-7 (March, 1958).

Magnetic domain patterns were observed on iron whiskers growing in [111], [100], and [110] directions. In most cases the patterns on unmagnetized whiskers are very simple and subject to straightforward interpretation. Patterns on {100} faces were observed to change after annealing above the Curie temperature. Domain arrangements were observed which produce intersecting boundaries at the crystal surface which do not collect magnetite. Dagger patterns which form on {110} surfaces under application of normal fields were studied and the effect of misoriented surfaces on these patterns was investigated.

538.245

458. DOMAIN OBSERVATIONS ON IRON WHISKERS. R.W.DeBlois and C.D.Graham, Jr.
J. appl. Phys., Vol. 29, No. 3, 528-9 (March, 1958).

The authors confirmed the appearance in iron whiskers of domain walls which apparently violate the restriction that the normal component of magnetization must remain constant across the wall. These walls sometimes have a dotted or serrated appearance. Such walls were found in a closure domain structure which permits the calculation of an approximate value for the surface energy of the serrated wall; this energy is approximately ten times the energy of a normal 90° wall or five times the energy of a normal 180° wall. It is concluded that the serrated wall contains an inner structure which largely eliminates any free poles.

538.245

459. DOMAIN OBSERVATIONS ON IRON WHISKERS. R.W.DeBlois and C.D.Graham, Jr.
J. appl. Phys., Vol. 29, No. 6, 931-9 (June, 1958).

Ferromagnetic domain walls were observed by standard methods on iron whiskers. The whiskers are square in cross-section, generally 20 to 60 μ on a side, and up to one cm long. The whiskers are single crystals with the axis in a <100> direction and the faces nearly perfect {100} planes. The domain patterns are exceptionally clear and simple. Several characteristic patterns are described and represented with three-dimensional models; a feature common to many patterns is the V line, which consists of two plane walls meeting in a V with its apex at the whisker surface. The effects of applied fields and applied stresses on the domain structures were studied, and some observations made on whiskers small enough to approach a single-domain state.

538.245

460. ANTIFERROMAGNETIC DOMAIN WALLS AND THE MAGNETIZATION PROCESS IN α-Fe_2O_3. I.S.Jacobs and C.P.Bean.
J. appl. Phys., Vol. 29, No. 3, 537-8 (March, 1958).

The magnetic properties of α-Fe_2O_3 are of interest since it is a prototype of the class of antiferromagnetic substances possessing a weak ferromagnetism superimposed on the normal antiferromagnetic susceptibility. Two possible sources of the weak ferromagnetism, i.e. moment bearing antiferromagnetic domain walls and special ferromagnetic forms of Fe_2O_3, are considered from the standpoint of their magnetization processes. It is noted that moment-bearing or non-moment-bearing domain walls may be required by the presence of certain edge and screw dislocations. The net moment of a domain wall may reverse by a wall displacement process or by the motion of a boundary within the domain wall, i.e. a Bloch line. Measurement of the rotational hysteresis in α-Fe_2O_3 proves that the weak ferromagnetism is not caused by a nonepitaxial second phase ferrimagnetic impurity. It is concluded that the behaviour of α-Fe_2O_3 at room temperature can be ascribed to moment bearing domain walls magnetizing by Bloch line motion, and/or ferrimagnetic Fe_2O_3 basal intergrowths in exchange contact with the antiferromagnetic lattice (Meiklejohn effect). The low temperature state can also be qualitatively understood with this model.

ELECTROMAGNETISM. MAGNETOHYDRODYNAMICS

538.3 : 530.12

461. VACUUM ELECTRODYNAMICS ON A MERRY-GO-ROUND. J.Ise and J.L.Uretsky.
Amer. J. Phys., Vol. 26, No. 7, 431-5 (Oct., 1958).

Maxwell's equations in a relativistic, rotating reference frame are discussed by use of a covariant formalism.

538.3 : 530.12

462. LAWS OF STATIC ELECTRICITY AND MAGNETISM IN AN ARBITRARY FRAME OF REFERENCE. H.Arzeliès and J.Henry.
C.R. Acad. Sci. (Paris), Vol. 247, No. 11, 815-17 (Sept. 15, 1958). In French.

Relativistic electromagnetic equations are expressed as covariant equations in 3-space. An expression derived for the electric induction vector in an arbitrary frame involves the magnetic induction and polarization as well as the electric intensity vector. Application to static fields in a rotating medium is briefly considered.

R.A.Newing

538.3

463. A CLASSICAL THEORY OF THE CREATION AND ANNIHILATION OF ELECTRIC CHARGES. E.Durand.
Ann. Fac. Sci. Univ. Toulouse, Vol. 20, 99-110 (1956). In French.

Proposes a generalization of the classical Maxwell–Lorentz equations in which charge is not conserved. R.J.N.Phillips

538.3

464. THE GREEN'S FUNCTION FOR MAXWELL'S [ELECTROMAGNETIC] EQUATIONS FOR INHOMOGENEOUS MEDIA. N.A.Khizhnyak.
Zh. tekh. Fiz., Vol. 28, No. 7, 1592-609 (1958). In Russian.

538.3

465. THE EQUIVALENCE OF ELECTRIC AND MAGNETIC SOURCES. P.E.Mayes.
I.R.E. Trans Antennas and Propagation, Vol. AP-6, No. 3, 295-6 (July, 1958).

538.3

466. AMPERE'S LAW AND THE VECTOR POTENTIAL. S.J.Raff.
Amer. J. Phys., Vol. 26, No. 7, 454-60 (Oct., 1958).

Some general features of several elementary methods of determining the magnetic field of a current configuration are examined. Ampere's law, the circuital form of Maxwell's equation and a derived relation between the magnetic field and the vector curl of the current, are each applied to the simple problem of computing the magnetic field due to a thin current dipole in a conducting medium. The significance of closed current paths and the conditions under which the return currents in the medium must be included in the computation are discussed for the d.c. case. The conclusions concerning d.c. currents are then considered in relation to a.c. problems and the use of the vector potential in aerial problems. These considerations indicate why only aerial currents enter into the computation of vector potential and the nature of the "thick antenna" problem.

538.3 : 517.4

SCALAR–VECTOR ANALOGUE OF GREEN'S THEOREM. See Abstr. 1

538.3 : 532.5

467. AXIALLY SYMMETRIC MAGNETOHYDRODYNAMICAL MOTION. CASE OF SMALL OSCILLATIONS IN A SPHEROIDAL FLUID MASS. C.Agostinelli.
Atti Accad. Sci. Torino I, Vol. 91, No. 1, 263-98 (1956-57). In Italian.

The propagation of waves parallel to the axis is discussed in the case of a uniformly rotating liquid subject to a magnetic field applied in the direction of the axis. Small oscillations in a slowly rotating spheroid are considered in detail. The possible velocities of wave propagation for given pulsatance appear as the roots of a transcendental equation. R.A.Newing

538.3 : 532.5

468. MAGNETOHYDRODYNAMICAL WAVE IN AN ELECTRICALLY CONDUCTING FLUID IN AN UNLIMITED TUBE OF RECTANGULAR CROSS-SECTION. M.T.Vacca.
Atti Accad. Sci. Torino I, Vol. 90, No. 2, 633-46 (1955-56). In Italian.

538.3 : 532.5 : 523.03

469. THE INSTABILITY OF A LAYER OF [AN ELECTRICALLY CONDUCTING] FLUID HEATED BELOW AND SUBJECT TO THE SIMULTANEOUS ACTION OF A MAGNETIC FIELD AND ROTATION [CORIOLIS ACCELERATION]. T.Namikawa.
J. Geomagn. Geoelect., Vol. 8, No. 2, 81-5 (June, 1956).

538.3 : 532.5

470. MAGNETO-HYDRODYNAMIC OSCILLATIONS OF A [INFINITELY LONG CYLINDER OF] CONDUCTING LIQUID MASS ROTATING IN A UNIFORM MAGNETIC FIELD. T.Namikawa.
J. Geomagn. Geoelect., Vol. 7, No. 4, 97-104 (Dec., 1955).

It is shown that the periods of oscillations are much different from that of non-rotating cylinder, when the Coriolis force is much

larger than the electromagnetic force. Two periods T_1, T_2 for one mode of oscillation are obtained ($T_1 > T_0 > T_2$, where T_0 is the period of non-rotating cylinder).

538.3 : 532.5

471. THE ANALOGUE OF KELVIN'S THEOREM IN HYDROMAGNETICS. J.De.
Naturwissenschaften, Vol. 44, No. 8, 256 (1957).

Consideration of the hydromagnetic field equations of an infinitely conducting, incompressible, inviscid fluid shows that the magnetic lines are frozen in the fluid, i.e. they move with the fluid in the same sense as vortex lines do in the hydrodynamic field under the action of conservative forces. It is shown that it follows from this that the circulation $\oint v.ds$ along a closed magnetic line is a constant of the motion. R.C.Glass

538.3 : 532.5

472. MAGNETOHYDRODYNAMICS.
D.Bershader and R.Landshoff.
Phys. Today, Vol. 11, No. 4, 26-8 (April, 1958).

Report of a conference held at Stanford (U.S.A.) on 16-20 December 1957 and sponsored by the Lockheed Missile Systems Division. The proceedings are to be published in book form by the Stanford University Press.

538.3 : 537.565

473. PROPERTIES OF AN IONIZED GAS OF LOW DENSITY IN A MAGNETIC FIELD. IV.
S.Chandrasekhar, A.N.Kaufman and K.M.Watson.
Ann. Phys. (New York), Vol. 5, No. 1, 1-25 (Sept., 1958).

For Pt III, see Abstr. 1784 (1958). A systematic method is described for solving the Boltzmann equation for the steady states of an ionized gas of low density in a strong magnetic field. On the assumption that the term representing the Lorentz force in the Boltzmann equation dominates all others, the solution is developed as a series in inverse powers of the gyration frequency ω. The solution is explicitly carried out to the first order in ω^{-1}. Expressions for the drifts which arise in the first order are also obtained.

538.3 : 532.5 : 537.56

OSCILLATIONS OF A PLASMA CYLINDER IN AN EXTERNAL MAGNETIC FIELD. See Abstr. 361

538.34 : 532.5 : 537.56

GENERATION AND THERMALIZATION OF PLASMA WAVES. See Abstr. 359

ELECTROMAGNETIC WAVES AND OSCILLATIONS

538.56 : 534.2

EXPERIMENTS ON CM WAVES IN ANALOGY WITH ACOUSTIC TECHNIQUES. See Abstr. 132

538.561 : 535.3

474. INDUCED AND SPONTANEOUS EMISSION IN A COHERENT FIELD. I.R.Senitzky.
Phys. Rev., Vol. 111, No. 1, 3-11 (July 1, 1958).

The interaction between a coherently oscillating radiation field, such as is generally encountered in microwave experiments, and a number of similar atomic systems coupled to the field through their electric dipole moments is analysed for the case of resonance between atomic system and field, with both the field and molecules treated quantum-mechanically. Expressions are derived for the expectation value of field strength and the energy, and comparison between the two makes it possible to distinguish between coherent and incoherent parts of the energy, the former having its counterpart in the expectation value of the field strength, while the latter has no such counterpart. Terms corresponding to induced and spontaneous emission are identified, and it is shown that the latter includes both coherent and incoherent components. Special situations related to masers and to the coherence of spontaneous radiation are discussed. The distinction between the behaviour of correlated and uncorrelated states is examined, and it is shown that both the coherent emission from uncorrelated states and the incoherent emission from correlated states may be proportional to the square of the number of molecules. The phase of the field is predictable for the coherent emission but unpredictable for the incoherent emission.

538.566

475. SCATTERING FROM A SMALL ANISOTROPIC ELLIPSOID. R.A.Hurd.
Canad. J. Phys., Vol. 36, No. 8, 1059-71 (Aug., 1958).

Scattering of an electromagnetic wave by a small ellipsoid having tensor permeability and dielectric properties is dealt with by expanding the fields as power series in λ^{-1}. Consideration is given to the first three terms of the expansion.

538.566

476. ON THE REFLECTION OF ELECTROMAGNETIC WAVES FROM A DIELECTRIC CYLINDER. H.Wilhelmsson.
Chalmers Tekn. Högsk. Handl., No. 168, 16 pp. (1955).

It is shown that the general problem of reflection of an obliquely incident plane electromagnetic wave from a dielectric cylinder can be solved exactly. This is done for the two cases with the magnetic or the electric field vector of the incident plane wave polarized perpendicularly to the dielectric cylinder. In each case both TM and TE modes have to be considered in the scattered wave and in the wave inside the dielectric cylinder. For the general case of an arbitrarily polarized plane incident wave, the solution is obtained by superposition of the two separate solutions. The coupling between the modes is also studied, and is shown to vanish for perpendicular incidence.

538.566

477. DIFFRACTION PATTERNS AT THE PLANE OF A SLIT IN A REFLECTING SCREEN. R.K.Hadlock.
J. appl. Phys., Vol. 29, No. 6, 918-20 (June, 1958).

Measurements were made of the diffraction pattern in slits ranging in width from 0.2 to 2.5 wavelengths. Microwave radiation of 10.4 and 16 cm was used. Ratios of intensity in the slit to the intensity of the unperturbed beam were found for plane polarized radiation incident on the conducting slit screen. Comparison with diffraction patterns in the plane of circular apertures was made. A peak of intensity was found for the slit width of one-half wavelength and a plateau was observed in the plot of intensity v. slit width in the region of width equal to one wavelength. A theory involving multiple reflections from the edges was utilized to explain the variations of intensity in the plane of the slit. The electric field was studied when polarized parallel, and also perpendicular, to the slit edges. A high intensity was found near the edges when the electric field was polarized perpendicular to them.

538.566

478. DIFFRACTION BY A PERFECTLY ABSORBING THIN SCREEN. C.C.Derwin.
J. appl. Phys., Vol. 29, No. 6, 921-2 (June, 1958).

A plane screen only one-eighth wavelength thick, which absorbed 99% of the intensity of normally incident microwave, was constructed using glass with an electrically conducting surface. Comparative measurements were made of the diffraction pattern in and near slits in "perfectly absorbing thin screens" and "perfectly reflecting thin screens". It was found that the diffraction pattern of the slits on the side of the screens opposite the source was the same for both screens at distances greater than a half-wavelength. Even in the planes of the slits the diffraction patterns for these two screens differed by less than the experimental error for slits wider than one wavelength.

538.566

479. DIFFRACTION BY A WIDE SLIT AND COMPLEMENTARY STRIP. I. R.F.Millar.
Proc. Cambridge Phil. Soc., Vol. 54, Pt 4, 479-96 (Oct., 1958).

Consideration is given to the problem of the diffraction of an E-polarized plane wave by an infinite slit. The solution takes the form of a series in inverse powers of the ratio of slit-width to wavelength of the incident wave, and is based on the solution by successive substitutions of a pair of integral equations. The current densities induced on both halves of the screen are calculated, from which is deduced the electric field in the slit. The far-field is determined from the aperture distribution, and an asymptotic expression is found for the transmission coefficient as a function of the angle of incidence and the ratio of slit-width to wavelength. While most previous work has been confined to near-normal incidence, the present theory is uniformly valid for all angles of incidence.

538.566

480. DIFFRACTION BY A WIDE SLIT AND COMPLEMENTARY STRIP. II. R.F.Millar.
Proc. Cambridge Phil. Soc., Vol. 54, Pt 4, 497-511 (Oct., 1958).

The notions developed in Part I are here applied to the case of H-polarization. Induced current densities, aperture and far fields,

and the transmission coefficient are again found in the form of infinite series in inverse powers of the slit-width to wavelength ratio. By means of Babinet's principle, the solution for diffraction by a strip is obtained. A detailed comparison is made with values of the transmission coefficients for both polarizations found previously and by the present method. It appears that this theory provides accurate information when the slit-width is greater than about a wavelength.

538.566

481. THE DIFFRACTION OF ELECTROMAGNETIC WAVES AT AN INFINITELY LONG CIRCULAR CYLINDER. R.Burberg.
Z. Naturforsch., Vol. 11a, No. 10, 800-6 (1956). In German.

Expressions are developed for the field intensity inside and outside the cylinder. Special cases then considered are: (1) the incident wave travelling (a) parallel, (b) perpendicular to the cylinder axis; (2) the mean field inside a very thin cylinder. G.F.Lothian

538.566 : 535.317 : 621.396.677.85

MICROWAVE LENSES. See Abstr. 168

538.566 : 621.372

482. PROPAGATION OF MICROWAVES ALONG A SOLID CONDUCTOR EMBEDDED IN THREE COAXIAL DIELECTRICS. S.K.Chatterjee and R.Chatterjee.
J. Indian Inst. Sci. B, Vol. 38, No. 3, 157-71 (July, 1956).

The problem is treated as a boundary value problem. The field components in terms of the axial power flow are derived for the three dielectric media, together with the characteristic equations for the propagation constants of E_0 and H_0 modes. The characteristic equations for propagation constants in (1) a solid conductor embedded in free space, (2) a dielectric rod, and (3) a dielectric tube,are derived for the two modes E_0 and H_0 as special cases.

538.566 : 621.372

483. PROPAGATION OF MICROWAVES ALONG A SINGLE CONDUCTOR EMBEDDED IN THREE CO-AXIAL DIELECTRICS. II. S.K.Chatterjee and R.Chatterjee.
J. Indian Inst. Sci. B, Vol. 39, No. 2, 71-82 (April, 1957).

The characteristic equation for the EH wave is derived. It is shown, as a special case, that the asymmetric wave EH_1 cannot be propagated along a solid conductor embedded in free space due to very high attenuation. Field components in terms of the axial power-flow are derived.

538.566.2

484. ON THE VELOCITY OF ENERGY IN AN IONIZED GAS SUBJECT TO A MAGNETIC FIELD. M.De Socio.
Atti Accad. Sci. Torino I, Vol. 90, 563-6 (1955-56). In Italian.

It is shown that, in the case of a plane wave propagated in a direction inclined to an applied magnetic field, the component of the mean energy velocity in the direction of wave propagation is equal to the group velocity. R.A.Newing

538.566.2

485. PROPAGATION OF AN ELECTRIC PULSE THROUGH A HOMOGENEOUS AND ISOTROPIC MEDIUM. B.K.Bhattacharyya.
Geophysics, Vol. 22, No. 4, 905-21 (Oct., 1957).

The propagation is considered of a step-function pulse in a medium characterized by the three electric constants, permittivity ϵ, permeability μ and conductivity σ. The effect of the displacement current on the propagation is fully taken into account. Expressions for the electric and magnetic fields are determined. It is shown that the time of travel of the pulse and the initial and final values of any one of the non-vanishing field components (all of which can be measured) fully specify the values of conductivity and permittivity of the medium.

538.566.2

486. ON A RIGOROUS SOLUTION OF MINKOWSKI'S EQUATIONS FOR CONDUCTORS IN MOTION AND ITS PHYSICAL INTERPRETATION. G.Carini.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 2, No. 3, 253-60 (1955-56). In Italian.

The solution obtained defines the motion of an electromagnetic plane wave in the conductor. For perfect conductors, and also for high-frequency waves in imperfect conductors, it is shown that attenuation is minimum for waves propagated in the direction of the motion of the conductor. R.A.Newing

538.566.2

487. PROPAGATION OF PLANE ELECTROMAGNETIC WAVES IN INHOMOGENEOUS MEDIA. H.Osterberg.
J. Opt. Soc. Amer., Vol. 48, No. 8, 513-21 (Aug., 1958).

The laws of propagation of plane electromagnetic waves along z are derived from Maxwell's equations for inhomogeneous media in which the dielectric constant and the electric conductivity are functions of z and in which the magnetic permeability is constant. The corresponding wave equation is reduced to a Riccati differential equation. A simple method is evolved for treating this Riccati equation without approximation. As a result, it is shown that the laws of propagation depend primarily upon two physical parameters v(z) and u(z) which have the property v(z) = n and −u(z) = nK for homogeneous media, where n is the refractive index. The increase in phase retardation of the wave is always governed by the integral of v(z)dz, and v(z) is always the ratio of the phase velocity in vacuum to the phase velocity in the medium. It is shown that sufficiently continuous, single, infinite, inhomogeneous media cannot exhibit reflectance. Fresnel's coefficients of reflectance and transmittance are derived for normal incidence upon a plane boundary between two inhomogeneous media. The theory includes homogeneous media as special cases.

538.566.3

488. THE SCATTERING OF ELECTROMAGNETIC WAVES BY PLASMA OSCILLATIONS. N.Hokkyo.
J. Geomagn. Geoelect., Vol. 8, No. 1, 1-8 (March, 1956).

Theory of plasma oscillations is applied to the problem of the scattering of ~1000 Mc/s waves in the E layer of the ionosphere. It is assumed that a region of the ionosphere having an irregular or turbulent character contains "oscillating domains" or "coherent units" in which free electrons perform synchronous oscillations. These domains are shown to be effective in scattering waves of frequencies $\sim(c/v)\,\omega_p$, where ω_p is the plasma frequency, v the mean thermal speed of electrons, and c the velocity of light. A rough estimate indicates that the scattered wave may be observable in a properly set-up experiment, and that its angular dependence is $(\sin\theta/2)^{-1}$, θ being the scattering angle.

NUCLEAR AND ATOMIC PHYSICS
APPARATUS. PARTICLE DETECTORS

539.1.07 : 539.16.08

489. SOME METHODS IN NUCLEAR SPECTROSCOPY. B.Van Nooijen.
University of Delft Dissertation (1958) 85 pp.

Scintillation counters and beta spectrometers, and their use in coincidence, angular correlation and polarization measurements, are described in detail. The methods discussed are applied to an investigation of the decay of Sc^{48} and V^{48} to their common product Ti^{48}, producing spins and parities for all the levels involved. A.E.I. Research Laboratory

539.1.07 : 535.376 : 539.17

490. SCINTILLATION RESPONSE OF CsI(Tl) CRYSTALS TO FISSION FRAGMENTS AND ENERGY vs RANGE IN VARIOUS METALS FOR LIGHT AND HEAVY FISSION FRAGMENTS. C.B.Fulmer.
Phys. Rev., Vol. 108, No. 5, 1113-16 (Dec. 1, 1957).

A thin CsI(Tl) crystal was used as the phosphor of a scintillation detector of fission fragments. Light and heavy fragments from pile neutron fission of U^{235} were magnetically separated and scintillation pulse-heights in CsI(Tl) crystals determined as a function of range in various gases and metals. The relationship between pulse-height and fragment energy was found to be linear. Specific fluorescence of fission fragments in the crystal increases monotonically with specific energy loss. Energy v. range curves were obtained for median-mass light and heavy fragments in H_2, He, air, A, Al, Ni, and Au.

539.1.07

491. SPACE-CHARGE EFFECTS IN A PROPORTIONAL COUNTER. V.S.Venkatasubramanian.
J. Indian Inst. Sci. A., Vol. 39, No. 2, 125-8 (April, 1957).

From the known characteristics of the space charge, an expression for the gas multiplication in a proportional counter is derived as a function of the primary ionization. The results are applied to the case of α- and β-particle pulses.

539.1.07

492. COMBINATION ION CHAMBER–PROPORTIONAL COUNTER DOSIMETER FOR MEASURING GAMMA-RAY CONTAMINATION OF NEUTRON FIELDS. M.Slater, G.B.Bunyard and M.L.Randolph.

Rev. sci. Instrum., Vol. 29, No. 7, 601-5 (July, 1958).

A method for measuring low gamma-ray contamination in a fast neutron field is described by which a single detector is operated sequentially as an ionization chamber and as a proportional counter. The range of collecting voltage for which the apparent gas multiplication is independent of particle type or mode of operation was determined. The method attains high accuracy in the measurement of the ratio of neutron to total dose and has been applied to several neutron sources.

539.1.07 : 539.164.07

493. THE DETECTION OF ALPHA PARTICLES WITH ZnS SCINTILLATORS. J.Goldemberg, E.Silva and S.S.Villaça.
An. Acad. Brasil. Cienc., Vol. 27, No. 2, 141-50 (1955).
In Portuguese.

Experiments were carried out to determine the optimum conditions for the use of ZnS phosphors in counting α-particles. Best results were obtained with a collimated beam and a phosphor thickness of the order of the range of the α-particles in the screen.

L.Pincherle

539.1.07

494. ON THE GAS SCINTILLATION COUNTER.
W. Hanle and K.Schmidt.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 173-7 (1957). In German.

Describes an experimental study of "scintillation flashes" in various gases (O_2, N_2/O_2, Xe, Xe/N_2, N_2, A, A/N_2) when excited by 80 keV electrons for pressures varying over the range 0-500 mm Hg. Reference to α-particle counting is made.

J.D.Craggs

539.1.07

495. A SIMPLE [CONTINUOUS] MONITOR FOR AIRBORNE ALPHA PARTICLES. R.D.Hiebert, R.N.Mitchell and D.B.Tod.
I.R.E. Trans Nuclear Sci., Vol. NS-4, No. 2, 66-9 (Dec., 1957).

The single-channel system can detect activity concentrations of ten times maximum permissible level for plutonium and gives indication of accumulated activity at 10 min intervals. The instrument is designed with emphasis on simplicity, reliability, flexibility of use, and ease of decontamination.

539.1.07 : 537.534 : 537.533 : 621.384.6 : 621.387.464

496. CONTINUOUS ENERGY MONITOR FOR THE EXTERNAL BEAM OF A CYCLOTRON. J.A.Northrop and R.H.Stokes.
Rev. sci. Instrum., Vol. 29, No. 4, 287-90 (April, 1958).

A simple scintillation counter system is described which monitors the average energy of particles in the external beam of a cyclotron and simultaneously serves as a current integrator. Energy changes are continuously presented on a chart recorder, thus allowing the machine energy to be held constant to a high degree of accuracy over extended runs. In typical operation using 14 MeV deuterons, the average energy may be held constant to within 0.07%.

539.1.07

497. FAST SODIUM IODIDE SPECTROMETER AND ITS APPLICATION TO MILLIMICROSECOND TIME MEASUREMENT.
L.E.Beghian, G.H.R.Kegel and R.P.Scharenberg.
Rev. sci. Instrum., Vol. 29, No. 9, 753-7 (Sept., 1958).

A scintillation counter using pure NaI cooled to liquid nitrogen temperature was developed. The photo-peaks of Co^{57} γ-rays (122 keV) and Cs^{137} γ-rays (662 keV) were found to have a full width at half-height of 33% and 14%, respectively. A 7 in. quartz light pipe was used between scintillator and photomultiplier. The decay time of the fluorescent light was found to be 27 mμsec. For fast time measurements a time-to-pulse-height convertor was constructed, which operates in the range from 0 to 100 mμsec. The convertor was used in conjunction with two scintillation counters using plastic (Pilot B) scintillators. The time resolution for the detection of annihilation γ-rays was found to be $2\tau_0 = 2.3$ mμsec. With one plastic and the cooled NaI scintillator the time resolution was found to be $2\tau_0 = 2.7$ mμsec. The possible factors contributing to the time resolution are discussed.

539.1.07

498. LARGE-AREA DISTILLED WATER CERENKOV COUNTER.
B.N.Srivastava.
J. sci. industr. Res., Vol. 17B, No. 7, 281-2 (July, 1958).

A volume of distilled water is viewed by a single photomultiplier. The efficiency of the counter as a function of distance of the incident cosmic-particle from the photomultiplier is determined, using two G.M. counters, one above and one below the volume, by comparing the double coincidence rate of these two counters with the triple coincidence rate with the Cherenkov counter. Efficiency is high within a distance of 6 in., but falls off rapidly beyond.

A.E.I. Research Laboratory

539.1.07 : 535.23.08

499. SEMICONDUCTOR P–N JUNCTION RADIATION COUNTER.
B.Salzberg and K.Siegel.
Proc. Inst. Radio Engrs, Vol. 46, No. 8, 1536 (Aug., 1958).

Briefly reports some tests using diodes operated at the onset of avalanche breakdown, at -78°C or 0°C to reduce the rate of thermally generated pulses, which show pulses associated with illumination of the diode with visible light or with irradiation with β-particles from Sr^{90}–Y^{90}.

F.F.Roberts

539.1.07

500. EXPERIMENTAL STUDY OF METHOD OF BUBBLE FORMATION IN BUBBLE CHAMBERS. W.I.Goldburg.
Phys. of Fluids, Vol. 1, No. 4, 353-4 (July-Aug., 1958).

A static electric field of 15 kV/cm was applied across a small propane bubble chamber, which was then expanded in the conventional manner when a beam of 450 MeV protons was passed through it. The bubble density along the tracks was measured with both field on and field off. Within statistics (±4%) no difference in bubble density was observed for the two cases. To interpret this result it is assumed that δ-rays produce bubbles if they deposit a certain minimum amount of energy within a critical volume of the liquid. It is then concluded from this experiment that either recombination effects are not important in bubble formation or that the recombination time of ions in a critical volume of propane is $\leq 10^{-11}$ sec. This figure appears to represent a reasonable theoretical estimate of the sensitive time of propane, liquid hydrogen, and liquid helium.

539.1.07

501. USE OF FREONS IN BUBBLE CHAMBERS. D.V.Bugg.
Rev. sci. Instrum., Vol. 29, No. 7, 587-9 (July, 1958).

The sensitive regions of several Freons in a bubble chamber were determined. CF_3Br, Freon 13B1, was found to be sensitive at 30°C, at which temperature the equilibrium vapour pressure is only 264 lb/in^2. Because of its pleasant handling characteristics, and the fact that it can be used in any chamber designed for propane, it is suggested that it may find considerable use as a "heavy" liquid in large chambers. The time needed for bubbles to redissolve, and the difficulties implicit in the use of mixtures of liquids are discussed.

539.1.07

502. A [PHOTOMETRIC] METHOD TO DETERMINE THE CHARGE OF PARTICLES STOPPING IN NUCLEAR EMULSIONS.
T.Johansson.
Ark. Fys., Vol. 13, Paper 12, 129-44 (1958).

The image of the track in the emulsion was projected on a narrow slit placed in front of a photomultiplier and moved perpendicularly across the slit. The slit was parallel to the direction of the track and the absorption of light was measured by means of the photomultiplier and a recording instrument. The resolving power depends on the available track length, the quality and the degree of development of the emulsions. If track lengths of 100 μ are used in normally developed G 5 emulsions of good quality, it is possible to separate doubly and singly charged particles in about 95% of the cases, the resolution being better for multiply charged particles.

539.1.07

503. ON THE METHODS OF IONIZATION MEASUREMENT IN G-5 AND K-5 EMULSIONS.
G.Cortini, G.Luzzatto, G.Tomasini and A.Manfredini.
Nuovo Cimento, Vol. 9, No. 4, 706-20 (Aug. 16, 1958).

The results of measurements of ionization made in Ilford G-5 and K-5 photoemulsions by means of a semiautomatic apparatus are reported. The experimental fluctuations are in good agreement with values derived by simple formulae of practical use. While all the models proposed as yet for the mechanism of track formation appear to be over-simplified, an assumption is proposed to explain the results. The different methods of measurement are compared and some suggestions are given.

539.1.07

504. A SEMI-AUTOMATIC DEVICE FOR NUCLEAR EMULSION SCATTERING MEASUREMENTS. M.Ferro-Luzzi and M.Muchnik.
Ricerca sci., Vol. 28, No. 7, 1451-6 (July, 1958). In Italian.

By coupling the micrometer eyepiece of the microscope to a calculating machine (Olivetti Tetractys) it is possible to calculate directly the second difference of the lateral displacements of the grains of the track. This enables the constant of scattering to be calculated in a third of the time required by the more normal method.

J.M.Hough

539.1.07

505. A COINCIDENCE CIRCUIT WITH RESOLVING TIME OF 2.2 mμsec AND DEAD TIME OF THE ORDER OF 5 mμsec OF POSSIBLE APPLICATION IN NUCLEAR PHYSICS.
U.Pellegrini, B.Rispoli and A.Serra.
Nuovo Cimento, Vol. 9, No. 1, 171-83 (July 1, 1958). In Italian.

A new high resolution coincidence circuit was studied for scintillation or Cherenkov counter experiments. The resolving time was found to be 2.2 mμ sec and the circuit is suitable for 5-fold or 6-fold coincidence arrangement. The circuit is given and the coincidence curve is shown. The circuit has a sensitivity of about 3 V and dead time of about 5 mμsec. The characteristics of the circuit as well as the characteristics of conventional coincidence circuits were measured.

539.1.07 : 537.54

MILLIMICROSECOND PULSE PRODUCTION BY R.F. SWEEPING OF ION BEAMS. See Abstr. 355

539.1.07

506. INSTRUMENTATION FOR FAST NEUTRON TIME-OF-FLIGHT STUDIES. R.V.Smith.
I.R.E. Trans Nuclear Sci., Vol. NS-5, No. 1, 10-12 (June, 1958).

Instrumentation was developed for measuring the energies of 1-4 MeV neutrons by means of their flight time over a 1 m path. Some problems involved in measuring the resultant 30-70 mμsec time intervals with an accuracy of a few percent are discussed, together with the limitations imposed by intensity considerations, presently available photomultipliers, and known electronic recording techniques. Some results are given showing the spectra of neutrons scattered from a primary energy of 4.3 MeV by zirconium, carbon, nickel, aluminium, and chromium.

539.1.07

507. VELOCITY FILTER FOR NUCLEAR SPECTROSCOPY.
L.H.T.Rietjens, O.M.Bilaniuk and W.C.Parkinson.
Rev. sci. Instrum., Vol. 29, No. 9, 768-9 (Sept., 1958).

The background resulting from nuclear reaction products of the same magnetic rigidity as the particles to be magnetically analysed is eliminated by preceding the magnetic analyser by a velocity filter of crossed electric and magnetic fields.

539.1.07 : 538.222

508. VERSATILE MAGNETIC RESONANCE SPECTROMETER.
J.A.Cowen and W.H.Tanttila.
Amer. J. Phys., Vol. 26, No. 6, 381-5 (Sept., 1958).

A Pound—Knight—Watkins marginal oscillator was modified by the addition of a vibrating capacitor in parallel with the tuning capacitor to produce a simple circuit which may be used to observe paramagnetic resonance at low fields, nuclear magnetic resonance, and nuclear quadrupole resonance. Suggestions are made as to the type of information which may be obtained in an undergraduate laboratory experiment.

539.1.07

509. MODIFIED SPIN-ECHO METHOD FOR MEASURING NUCLEAR RELAXATION TIMES. S.Meiboom and D.Gill.
Rev. sci. Instrum., Vol. 29, No. 8, 688-91 (Aug., 1958).

A spin echo method adapted to the measurement of long nuclear relaxation times (T_2) in liquids is described. The pulse sequence is identical to the one proposed by Carr and Purcell (Abstr. 6788/1954), but the r.f. of the successive pulses is coherent, and a phase shift of 90° is introduced in the first pulse. Very long T_2 values can be measured with appreciable effect of diffusion.

539.1.07 : 539.14 : 538.222

510. A SIMPLE ARRANGEMENT FOR STUDYING DOUBLE MAGNETIC RESONANCES, AND AN APPLICATION TO CARBON.
J.L.Motchane, E.Erb and J.Uebersfeld.
C.R. Acad. Sci. (Paris), Vol. 246, No. 12, 1833-5 (March 24, 1958). In French.

An arrangement for the simultaneous observation of electron spin and nuclear spin resonances is described. A rectangular coil is placed at the centre of a TE_{011} full wave cavity, so that the conductors are either perpendicular to the electric field or in a region where this field is weak, and hence the Q of the cavity is not much reduced. This arrangement was used to observe the enhancement of the nuclear magnetic resonance signal of protons in benzene produced by dynamic polarization due to saturation of the electron spin resonance of powdered carbon suspended in the benzene.

J.M.Baker

539.1.07

511. SUPPRESSING SIDE-BAND INTERFERENCE IN SUPER-REGENERATIVE R.F. SPECTROMETERS. C.Dean and M.Pollak.
Rev. sci. Instrum., Vol. 29, No. 7, 630-2 (July, 1958).

By slowly modulating the quench frequency, the side-band responses of a super-regenerative spectrometer to a nuclear resonance can be prevented from appearing in a recorded spectrum. When searching for an unsplit Zeeman component in a nuclear quadrupole spectrum, an equivalent simplification of the recorded spectrum can be obtained by slowly modulating the magnetic field. Satisfactory spectrometers and the required modulation and compensation circuits are described.

539.1.07 : 533.5

VACUUM TECHNIQUES IN THE ATOMIC ENERGY INDUSTRY. See Abstr. 114

ELEMENTARY PARTICLES

539.12 : 530.145

PARTICLE NOMENCLATURE. See Abstr. 44

539.12

512. ELASTIC SCATTERING AND INTRINSIC STRUCTURE OF ELEMENTARY PARTICLES.
D.I.Blohincev, V.S.Barašenkov and V.G.Grišin.
Nuovo Cimento, Vol. 9, No. 2, 249-57 (July 16, 1958).

Experimental data on elastic scattering of π^- mesons on protons with energy E = 1.3 GeV are analysed. It is shown that from the analysis of their angular distribution it is possible to determine the root-mean-square radius and to get data about the distribution of matter inside the nucleon. The root-mean-square "pion radius" is found to be equal to $\sqrt{\langle r^2 \rangle} = (0.82 \pm 0.06) \times 10^{-13}$ cm. In conclusion a possible experimental criterion of the existence of an elementary length is considered.

539.12 : 539.14

513. INTERPRETATION OF SCATTERING CROSS SECTIONS IN TERMS OF NUCLEAR SIZE. L.R.B.Elton.
Rev. mod. Phys., Vol. 30, No. 2(I), 557-60 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). The deductions that can be made from electron and nucleon scattering, and nucleon and pion absorption, are considered. An analysis of neutron and pion absorption cross-sections at 1.4 BeV is given and discussed.

R.J.N.Phillips

539.12 : 539.1.07

514. SIMULTANEOUS UTILIZATION OF MAGNETIC DEFLECTION AND COULOMB SCATTERING IN THE ESTIMATE OF PARTICLE MOMENTA. Y.B.Kim.
Rev. sci. Instrum., Vol. 29, No. 8, 680-8 (Aug., 1958).

The problem of estimating particle momenta under the simultaneous presence of magnetic deflection and Coulomb scattering is considered. This problem is of practical interest when nuclear emulsion plates are exposed under fields of many hundred kilogauss available from pulsed magnets. The estimation of momentum is separated into two parts, each utilizing the magnetic and the Coulomb effect, respectively. In this way one can fully utilize the numerous estimation techniques already developed and available in the literature for each of these two estimates. This separation, however, is carried out in such a way that the magnetic and the Coulomb estimate are statistically independent, and hence can be readily combined for an improved accuracy.

539.12 : 530.145

CONTRIBUTION TO THE THEORY OF THE MULTIPLE SCATTERING OF PARTICLES. See Abstr. 56

539.12

515. TIME REVERSAL AND POLARIZATION PHENOMENA IN REACTIONS INVOLVING γ-QUANTA. L.I.Lapidus.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 922-30 (1958). In Russian.

Polarization phenomena in photoproduction and in radiative capture of pions, as well as in the Compton effect, are considered. Consequences of invariance under time reversal are investigated. Wolfenstein's theorems (see Abstr. 3303, 4139/1952 and Annual Review of Nuclear Science, Vol. 6, 43, 1956) are extended to the case when the reactions under consideration involve γ-quanta.

539.12

516. ON THE DISPERSION RELATIONS FOR THE COMPTON EFFECT. A.A.Logunov and A.R.Frenkin.
Nuclear Phys., Vol. 7, No. 6, 573-8 (Aug., 1958).

A basis underlying the deduction of the dispersion relations for the Compton effect on nucleons in the absence of an unobservable energy region is presented.

539.12

517. SCATTERING OF LIGHT BY PROTONS.
W.J.Karzas, W.K.R.Watson and F.Zachariasen.
Phys. Rev., Vol. 110, No. 1, 253-60 (April 1, 1958).

Within the framework of the Chew–Low–Wick development an analysis of the scattering of photons from a nucleon is carried out. It is shown that an exact relationship exists between the Compton effect amplitude and the experimental meson–nucleon scattering phase-shifts for all multipoles except magnetic dipole and electric quadrupole provided that effects arising from currents inside the nucleon source (i.e. line currents) are slowly varying functions of photon energy. That part of the magnetic dipole scattering which can be described in terms of the isotopic vector part of the anomalous magnetic moments of the nucleon is also treated exactly. The cross-section for the Compton process is evaluated on the basis of the electric and magnetic dipole contributions only, since a non-recoil recoil theory is clearly expected to be poor for photon energies greater than 300 MeV. Fairly good agreement with experiment is achieved.

539.12

518. SCATTERING OF GAMMA RAYS BY A STATIC ELECTRIC FIELD. A.M.Bernstein and A.K.Mann.
Phys. Rev., Vol. 110, No. 4, 805-14 (May 15, 1958).

In an effort to observe Delbrück scattering (the scattering of photons by a static electric field), the absolute differential cross-sections for the elastic scattering of 1.33 MeV gamma-rays by lead, tin and uranium,and of 2.62 MeV gamma-rays by lead and tin, were measured for angles between 15^0 and 105^0. The observed scattering is the coherent sum of Delbrück, Rayleigh (bound electron), and nuclear Thomson scattering. The amplitude for the latter process is well-known; recent calculations of Rayleigh scattering, which are in good agreement with data obtained previously in this laboratory for gamma-ray energies below 1 MeV provide exact values of the amplitudes at 1.33 MeV and approximate values at 2.62 MeV. At 1.33 MeV, the difference between the observed scattering and that due to the Rayleigh and Thomson processes is not sufficiently large compared with experimental error to permit a definite identification of Delbrück scattering to be made. At 2.62 MeV, for lead, the experimental cross-sections at intermediate angles (30^0 to 75^0) are substantially larger than those calculated by extrapolation of the exact calculations, even when reasonable allowance for error in the extrapolation is made. The most probable explanation for this difference is an appreciable contribution from Delbrück scattering.

539.12 : 535.345 : 537.531

GAMMA-RAY AND NEUTRON ABSORPTION COEFFICIENTS OF INHOMOGENEOUS MATERIALS. See Abstr. 331

539.12

519. THE MAGNETIC MOMENT OF THE ELECTRON.
C.M.Sommerfield.
Ann. Phys. (New York), Vol. 5, No. 1, 26-57 (Sept., 1958).

The spin magnetic dipole moment of the electron is computed to fourth order in perturbation theory. The procedure is to consider a system of one electron moving in a constant external magnetic field. The Green's function and mass operator for the electron are computed as functions of this field. The expectation value of the mass operator is the self-energy of the electron and the magnetic moment is identified from that part of the self-energy linear in the external field. The techniques used are illustrated in a calculation of the second-order moment. The derivation of the fourth-order moment is sketched. It is found to be $\mu^{(4)} = 0.328\ (\alpha/\pi)^2$ in Bohr magnetons, where α is the fine-structure constant. This differs from the result of a previous calculation.

539.12

520. SHAPE OF THE HIGH-ENERGY END OF THE ELECTRON-BREMSSTRAHLUNG SPECTRUM.
E.G.Fuller, E.Hayward and H.W.Koch.
Phys. Rev., Vol. 109, No. 3, 630-5 (Feb. 1, 1958).

The elastic scattering of photons by the 15.11 MeV level in C^{12} was used to study with good energy resolution the number of photons at the high-energy end of a bremsstrahlung spectrum. The bremsstrahlung was produced by electrons accelerated in a betatron, the energy of which was varied in 35 keV increments. Targets were: a 0.025 in. diameter tungsten wire and the following foils, 0.001 and 0.010 in. tungsten, 0.002 in. thorium and 0.010 in. nickel. The foils were used to study the dependence of the spectrum shape upon target thickness and atomic number. When compared with Bethe–Heitler spectra corrected for target thicknesses, the data indicate an excess number of photons in the tip of the spectrum. The experimental number depends on the atomic number of the target and cannot vary more rapidly than $Z^{\frac{1}{2}}$.

539.12

521. ENERGY DISTRIBUTION OF INELASTICALLY SCATTERED ELECTRONS. G.W.Ford and C.J.Mullin.
Phys. Rev., Vol. 110, No. 2, 520-5 (April 15, 1958).

The spectrum of electrons at low energies and large scattering angles resulting from the scattering of high-energy electrons on atoms is considered. For thin scattering foils, the dominant contributions to this spectrum come from the following processes: (1) scattering accompanied by bremsstrahlung production; (2) scattering on bound electrons; and (3) Møller scattering followed by a single nuclear Coulomb scattering. It is found that the overwhelming majority of scattered electrons of low energy (i.e. kinetic energy of the order of the rest energy) come from processes (2) and (3), thus masking the peak predicted by Parzen et al. for process (1). For high incident energy and high-Z scatterers, the process (2) is dominant. It is shown that the cross-section for low energy scattered electrons from process (2) is related to the electron–electron forward-scattering cross-section. This affords a means of measuring this forward-scattering cross-section.

539.12

522. EFFECT OF DEGREE OF ORIENTATION AND CRYSTAL SIZE ON THE SCATTERING OF 20 keV ELECTRONS BY ALUMINUM. L.Marton, J.A.Simpson, J.A.Suddeth, M.D.Wagner and H.Watanabe.
Phys. Rev., Vol. 110, No. 5, 1057-60 (June 1, 1958).

The energy distribution of 20 keV electrons scattered by aluminium was measured as a function of degree of crystalline orientation and foil thickness. For equal physical thickness the foils with higher degree of orientation are electron-optically thinner. Over a range of thickness from 35 to 500 A, the values of the first two characteristic losses are 6.3 ± 0.1 eV and 15.0 ± 0.1 eV. They exhibit no systematic change with thickness greater than the experimental uncertainty. The intensity ratio between the two losses is essentially constant within this range. It is concluded that the low-lying (6.3 eV) loss is not due to the depolarization effect of grain boundaries.

539.12 : 539.14

ELECTRON SCATTERING AND NUCLEAR CHARGE DISTRIBUTIONS. See Abstr. 571

539.12

523. ON THE POLARIZATION OF ELECTRONS.
K.W.Hoffmann.
Naturwissenschaften, Vol. 45, No. 16, 377-81 (1958). In German.

A review of methods of obtaining and detecting polarized electrons, and of the experimental results concerning the longitudinal polarization of β-decay electrons. P.Roman

539.12

524. SIGN OF THE GRAVITATIONAL MASS OF A POSITRON.
L.I.Schiff.
Phys. Rev. Letters, Vol. 1, No. 7, 254-5 (Oct. 1, 1958).

If the virtual positrons responsible for the Lamb shift had negative weight, their anomalous contribution to atomic weights would have been detected by the Eötvös experiments.

J.C.Taylor

539.12

525. PAIR PRODUCTION AND BREMSSTRAHLUNG IN THE FIELD OF FREE AND BOUND ELECTRONS.
J.Joseph and F.Rohrlich.
Rev. mod. Phys., Vol. 30, No. 2(I), 354-68 (April, 1958).

The theory of these processes is discussed. Because of the complexity of the problems, cross-sections can only be calculated in the low- and high-energy limits. A critical survey of results, and a comparison with the (scanty) experimental data, are made.

R.J.N.Phillips

539.12

526. ORTHO-PARAPOSITRONIUM QUENCHING BY PARAMAGNETIC MOLECULES AND IONS. R.A.Ferrell.
Phys. Rev., Vol. 110, No. 6, 1355-7 (June 15, 1958).

The quenching of the long lifetime of orthopositronium by a paramagnetic molecule such as NO is generally interpreted as due to a spin flip resulting from exchange of the positronium electron with the single odd unpaired electron of the molecule. This concept is re-examined and it is found that spin flip is actually irrelevant, the only essential condition for quenching being that exchange be possible with one or more unpaired electrons. A further example is the well-known strong quenching caused by the O_2 molecule, whose two unpaired electrons can undergo exchange both with and without spin flip. In addition the quenching by paramagnetic ions in aqueous solution is briefly discussed. It is further noted that the quenching of orthopositronium by diphenylpicrylhydrazl (DPH) in benzene, generally regarded as a prime example of exchange quenching, is probably of quite different origin. Evidence is presented that this quenching is more likely due to a simple capture of the positronium atom by the DPH molecule.

539.12

527. A STUDY OF NUCLEON FORCES WITH REPULSIVE CORES. IV. CALCULATIONS OF THE SHAPE-DEPENDENT PARAMETERS IN NEUTRON–PROTON SCATTERING.
R.L.Preston and M.A.Preston.
Canad. J. Phys., Vol. 36, No. 5, 579-84 (May, 1958).

For Pt III, see Abstr. 7600 (1957). The magnitudes of the coefficients P and Q in the phase-shift expansion

$$k \cot \delta = -1/a + \tfrac{1}{2} r_0 k^2 - r_0^3 P k^4 + r_0^5 Q k^6 + \ldots$$

was investigated in the case of repulsive-core n–p interactions. For square, Gaussian, exponential, and Yukawa shapes, which fit experimental values of the scattering length and the effective range, the shape-dependent parameter P was computed as a function of r_c in both singlet and triplet states. Also, for square and Yukawa shapes, which fit the scattering length and effective range, Q was computed in the singlet state.

539.12

528. NUCLEAR SCATTERING OF 40 AND 95 MeV PROTONS.
A.E.Glassgold and P.J.Kellogg.
Phys. Rev., Vol. 109, No.4, 1291-4 (Feb. 15, 1958).

An analysis of recent elastic scattering experiments with 40 and 95 MeV protons is presented in terms of a velocity-independent and central complex potential. A summary of this and previous work at lower energies is given also.

539.12

529. ELECTROMAGNETIC STRUCTURE OF THE NEUTRON.
L.I.Schiff.
Rev. mod. Phys., Vol. 30, No. 2(I), 462-4 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). The structure is investigated assuming a specific form factor. It is concluded that present indications favour a vanishing charge density and an anomalous moment distribution like that of the proton. G.E.Brown

539.12 : 539.17

530. ANGULAR DISTRIBUTION OF NEUTRONS SCATTERED BY THE 2.80 keV RESONANCE IN SODIUM. R.C.Block.
Phys. Rev., Vol. 109, No. 4, 1217-18 (Feb. 15, 1958).

The angular distribution of neutrons scattered by the 2.80 keV resonance in sodium was measured with a pile beam and various combinations of boron and sodium filters. This distribution is found to be isotropic to within 10%.

539.12

531. NEUTRON–ELECTRON INTERACTION. L.L.Foldy.
Rev. mod. Phys., Vol. 30, No. 2(I), 471-81 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). A discussion is given of the background to the description of the electron–neutron interaction — which seems to come almost entirely from the electric field associated with the anomalous magnetic moment of the neutron. Contributions in terms of charge separation in the neutron, as predicted by meson theories, are discussed; that this effect is so small is surprising. G.E.Brown

539.12 : 536.48

ENERGY–MOMENTUM RELATION IN LIQUID HELIUM BY INELASTIC SCATTERING OF NEUTRONS. See Abstr. 262

539.12 : 538.114

CRITICAL SCATTERING OF NEUTRONS FROM FERROMAGNETS. See Abstr. 408

539.12

532. MEASUREMENT OF DIFFUSION LENGTH IN A LARGE BLOCK OF GRAPHITE. M.E.Clifford.
Atomic Energy Res. Establ. (Harwell), Rep. T/R287, 7 pp. (1957).

The distribution of thermal neutrons due to a source of fast neutrons in a large homogeneous block of graphite is considered (a) to determine where the measurement of the flux of thermal neutrons is possible; (b) to determine the nature of the boundary and source container effects. A method is given for calculating the diffusion length from the measurements. No attempt is made to consider the distribution of neutrons in a block of graphite with anisotropic properties, e.g. a block pierced by cylindrical holes.

539.12 : 530.19

MILNE'S PROBLEM IN THE CASE OF ANISOTROPIC SCATTERING. APPLICATION TO THERMAL NEUTRONS. See Abstr. 70

539.12 : 537.56

533. NEUTRON GENERATION FROM STRAIGHT PINCHES.
R.E.Dunway and J.A.Phillips.
J. appl. Phys., Vol. 29, No. 8, 1137-43 (Aug., 1958).

Experiments on the neutrons produced in deuterium gas during a high-current pulsed discharge are described. With 15 kV applied to a straight discharge tube 30 cm long, neutrons are produced during a 0.1 μsec pulse ~ 1.4 μsec after gas breakdown. The yield of 10^7 to 10^8 neutrons per discharge depends on gas purity and the discharge tube wall material. The axial asymmetry in neutron energy indicates that the neutrons are produced in reactions whose centre of mass moves perferentially towards the cathode.

539.12 : 537.525

534. NEUTRON PRODUCTION IN LINEAR DEUTERIUM PINCHES.
O.A.Anderson, W.R.Baker, S.A.Colgate, J.Ise, Jr and R.V.Pyle.
Phys. Rev., Vol. 110, No. 6, 1375-87 (June 15, 1958).

Approximately 10^8 neutrons per discharge were observed from magnetically self-constricted columns of deuterium plasma. These neutrons originated uniformly and simultaneously along a filament at the centre of the discharge tube, but measurements of their kinetic energies showed that they were produced by a small group of deuterons with large axial velocities and were therefore not of thermonuclear origin. It is proposed that the deuterons were accelerated by axial electric fields created by the growth of m = 0 ("sausage-type") instabilities.

539.12

535. THE POLARIZATION OF NEUTRONS EMITTED FROM NUCLEI BY PROTONS. E.J.Squires.
Proc. Phys. Soc., Vol. 72, Pt 3, 433-6 (Sept., 1958).

A discussion is given of the effects of the nuclear potential, and of multiple scattering, on the polarization of neutrons produced when nuclei are bombarded by high energy protons. The results indicate that, in order to explain the observed polarization at large angles, in particular its sign, multiple scattering must play an important part in the process.

539.12

536. STRUCTURE OF MESONS. H.P.Stapp.
Phys. Rev. Letters, Vol. 1, No. 8, 296-8 (Oct. 15, 1958).

Discusses a model in which mesons are bound states of a baryon and an antibaryon, coupled through a universal Fermi interaction based on global symmetry. Consequences for pion decay and for nucleon–hyperon forces are deduced. J.C.Taylor

539.12

537. SLOW MESONS ACCOMPANYING HIGH ENERGY INTERACTIONS. B.Chamany and A.G.Barkow.
Nuovo Cimento, Vol. 9, No. 4, 590-9 (Aug. 16, 1958).

Four nuclear events were found in G-5 emulsions, exposed in Texas at an altitude of 104 000 ft, where the breakup of the primary or the resulting interaction was accompanied by the emission of slow pions. Two of the events could be analysed as nucleon–nucleon interactions, and the energies of the slow pion produced were (8.06 ± 0.09) and (8.6 ± 0.1) MeV respectively. On the basis of existing theories on multiple meson production an attempt was made to calculate the probability of observing the production of a 10 MeV pion or less. Computations for two energies of the incident nucleon were made. When the incident nucleon in the laboratory system of co-ordinates was 1.38 GeV, one meson was produced and the probability that it had an energy of 10 MeV or less was found to be 6 in 100. If the incident nucleon is 11.1 GeV (N = 2), the probability that one meson had an energy of 10 MeV or less was found to be 2 in 1000.

539.12

538. STRONG INTERACTIONS AND ASSOCIATED PRODUCTION. C.Warner, III.
Phys. Rev. Letters, Vol. 1, No. 7, 246-7 (Oct. 1, 1958).

Models for the strong interaction Lagrangian are compared with the observed angular distributions in associated production by using perturbation theory. J.C.Taylor

539.12

539. ON THE POLARIZATION OF ELECTRONS EMITTED BY DECAYING μ-MESONS. L.B.Okun' and V.M.Shekhter.
Zh. eksper. teor. Fiz., Vol. 34, No. 5, 1250-3 (1958). In Russian.

An expression for the energy spectrum, angular distribution and polarization of electrons emitted by decaying polarized μ-mesons was obtained. The calculations are carried out for a decay-interaction Hamiltonian of the most general form characterized by ten complex constants. It is shown that experiments performed up to the present time are not sufficient for verification of the predictions made by Feynman and Gell-Mann (Abstr. 507/1958) and Marshak and Sudarshan (Abstr. 3301/1958). Apart of these experiments the polarization sign of the decaying μ-mesons should be measured.

539.12

540. EXPERIMENTAL STUDY OF HELICAL QUADRUPOLE LENSES FOR FOCUSING μ-MESONS. M.Morpurgo and A.Septier.
C.R. Acad. Sci. (Paris), Vol. 245, No. 26, 2496-9 (Dec. 23, 1957). In French.

A succession of quadrupole lenses of alternate signs is capable of confining a beam of high-energy particles, those of lower energies being eliminated. The same effect can be obtained by means of a helix wound with many parallel wires bearing currents of specified relative magnitudes. Experiments with this system are described. A.E.I. Research Laboratory

539.12

541. QUESTION OF A SECOND NEUTRAL PION. A.M.Baldin and P.K.Kabir.
Nuovo Cimento, Vol. 9, No. 3, 547-50 (Aug. 1, 1958).

The possible existence of a second neutral pion of zero isotopic spin is examined, with a view to the resolution of an apparent discrepancy involving pion photoproduction, pion scattering by protons, and the Panofsky ratio. It is concluded that the existence of this particle is not excluded by experiment; two possibilities for its mass and production amplitude are suggested. J.M.Cassels

539.12

542. KINEMATIC DEPOLARIZATION OF μ-MESONS EMITTED IN π-MESON DECAYS. J.Werle.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 1, 51-5 (1958).

Considers the effect of the transformation from the centre-of-mass frame of the pion into the laboratory frame. J.M.Cassels

539.12

543. MEASUREMENT OF PANOFSKY RATIO: NUCLEAR ABSORPTION OF π^- FROM K SHELL IN HYDROGEN. J.Fischer, R.March and L.Marshall.
Phys. Rev., Vol. 109, No. 2, 533-9 (Jan. 15, 1958).

The ratio of charge-exchange to radiative capture in hydrogen for stopped π^--mesons was determined by measuring the total photon spectrum in a lead glass Cherenkov counter. The ratio was found to be 1.87 ± 0.10. Possible contribution from in-flight pions was shown to be quite small. The error was estimated including this effect, as well as errors related to total number of events observed, and errors arising in the data analysis. Evidence for high-energy photon production by capture of slow π^- in elements other than hydrogen is discussed.

539.12

544. DIFFRACTION SCATTERING AND INTERACTIONS OF 0.57 GeV π^- IN EMULSIONS. A.Barbaro, G.Baroni and C.Castagnoli.
Nuovo Cimento, Vol. 9, No. 1, 154-61 (July 1, 1958).

A study of 570 MeV negative pion interactions with nuclei (and nucleons) is carried out with nuclear emulsion technique. Particular attention is given to diffraction scattering. The results on 152.2 m of followed track agree, as far as absorption is concerned, with the predictions of an optical model using dispersion rules, and a Fermi-type nuclear density distribution. The diffraction cross-section, instead, comes out larger than that predicted by the model, and this seems to confirm the results obtained with other techniques.

539.12

545. SCATTERING OF 37 MeV POSITIVE PIONS ON HYDROGEN. A.M.Sachs, H.Winick and B.A.Wooten.
Phys. Rev., Vol. 109, No. 5, 1750-4 (March 1, 1958).

Measurements were made of the differential scattering cross-sections of positive pions on hydrogen at 37 MeV using a liquid-hydrogen target and scintillation counters. Scattered pions are separated from other particles in the background by measuring the mass and energy of the particles using a pulse-height analysis on the signals from the scintillation counters. A partial wave analysis is made of the experimental results assuming S- and P-wave scattering. The results obtained are: $\alpha_3 = -4.11 \pm 1.09$ deg, $\alpha_{33} = 3.12 \pm 0.79$ deg, $\alpha_{31} = -0.32 \pm 0.73$ deg.

539.12

546. DETERMINATION OF THE $\pi-\pi$ INTERACTION STRENGTH FROM $\pi-$N SCATTERING. C.Goebel.
Phys. Rev. Letters, Vol. 1, No. 9, 337-9 (Nov. 1, 1958).

The class of Feynman diagrams contributing to $\pi + N \rightarrow N + \pi + \pi$ which have a single pion exchange, exhibit a pole at the (unphysical) value of the momentum transfer $\Delta^2 = -\mu^2$. It is shown how the residue at this pole determines the $\pi-\pi$ scattering cross-section. Assuming other terms do not interfere too badly, this residue should be detectable at high energy scattering with small nucleon recoil. J.C.Taylor

539.12

547. MULTIPLE MESON PRODUCTION IN ELECTRON-PROTON COLLISIONS. A.D.Levine.
Phys. Rev. Letters, Vol. 1, No. 3, 111-12 (Aug. 1, 1958).

Presents the results of a calculation of the $e + p \rightarrow e + p + \pi^+ + \pi^-$ cross-section, using Chew–Low matrix elements for the current operator. R.J.N.Phillips

539.12

548. NEUTRAL MESONS ARISING IN THE PHOTOPRODUCTION OF PION PAIRS. A.D.Levine.
Phys. Rev., Vol. 109, No. 2, 515-17 (Jan. 15, 1958).

The cross-sections for neutrons obtained in the photoproduction of pion pairs have been computed using the Wick–Chew–Low formalism. It is found that in the case of neutral mesons, one must consider the contributions obtained from terms giving rise to two P-wave mesons. The latter arise chiefly from the anomalous magnetic moment interaction, and alter the results obtained from terms giving rise to one S- and one P-wave meson by a factor of about 50% for neutral mesons. The results for charged mesons obtained by Zachariasen and Cutkosky (Abstr. 7728/1956) are not altered appreciably. The model so obtained has many features of the model for single meson photoproduction as given by Chew and Low.

539.12 : 539.17

549. RECOIL PROTONS FROM MESON PHOTOPRODUCTION IN HYDROGEN AND DEUTERIUM. R.Smythe, R.M.Worlock and A.V.Tollestrup.
Phys. Rev., Vol. 109, No. 2, 518-25 (Jan. 15, 1958).

The spectrum of photoprotons produced by 500 MeV bremstrahlung on hydrogen and deuterium was measured at laboratory angles of 29.7°, 41.2°, and 51.8° with a telescope of three scintillation counters. From the hydrogen data the π^0 cross-section of hydrogen was obtained, which agrees with the previous results of this laboratory. The contribution of the deuterium photodisintegration reaction was subtracted from the deuterium counting rate and the deuterium to hydrogen ratio of recoil protons from meson photoproduction was obtained. This ratio was also calculated from the deuterium π^- and hydrogen π^0 photoproduction cross-sections, by means of the "spectator model" of the deuteron. In this model photons interact with only one of the deuterium nucleons and the initial momentum of the target nucleon is taken into account. The ratio predicted by this model is significantly larger than the experimental ratio.

539.12

550. $\theta_1^0 - \theta_2^0$ MASS DIFFERENCE. E.Boldt, D.O.Caldwell and Y.Pal.
Phys. Rev. Letters, Vol. 1, No. 4, 150-2 (Aug. 15, 1958).

Twelve cases of hyperon production are interpreted as $\bar{\theta}^0 + n \rightarrow Y + \pi$ with seven Λ^0's and five $\Sigma^\pm$. Evidence from 120 $\theta_1^0 \rightarrow \pi^+ + \pi^-$ decays, with the particle-mixture theory suggest a value of $\hbar/\tau_1$ for the $\theta_1^0 - \theta_2^0$ mass difference, where τ_1 is the proper lifetime of θ_1^0. E.J.Burge

539.12

551. INTERACTIONS IN FLIGHT OF NEGATIVE HEAVY MESONS. S.Nilsson and Å.Frisk.
Ark. Fys., Vol. 14, Paper 18, 277-92 (1958).

Forty-one K^- track length were followed in the energy interval 0-140 MeV. Two hundred and eight interactions in flight are analysed to yield the total cross-section per nucleus in emulsion $\sigma = 780 \pm 60$ millibarns. The corresponding average total nucleon cross-section in nuclear matter is calculated to be $\sigma = 80 \pm 15$ millibarns. The mean free path $\lambda = 0.95 \times 10^{-13}$ cm implies a large absorptive potential ~60 MeV. The derived limits on the free neutron cross-sections do not contradict the assumption that charge independence holds in the absorption and scattering processes. The differential cross-section for elastic scattering between 5^0-30^0 is given. An attractive K^- nuclear potential is inferred from the percentage of re-emerging K^--mesons.

539.12

552. STUDY OF THE INTERACTION OF POSITIVE K MESONS. J.E.Lannutti, S.Goldhaber, G.Goldhaber, W.W.Chupp, S.Giambuzzi, C.Marchi, G.Quareni and A.Wataghin.
Phys. Rev., Vol. 109, No. 6, 2121-32 (March 15, 1958).

Continuing the programme on the study of positive K-mesons, the authors investigated the interactions of K-mesons with hydrogen and complex nuclei in photographic emulsions primarily in the energy interval 100 to 220 MeV. Interactions found in 320 m of K^+ track length followed, of which 227 m were in the energy interval 100 to 220 MeV are reported. The exposure was made to an enriched K-meson beam at the Berkeley Bevatron. The ratio of K-mesons to minimum ionizing background particles ranged from 1 : 1 to 1 : 3 across the stack. Thirteen new K–hydrogen scattering events were found and added to those previously published. The K–H cross-section was found to be energy-independent in the energy interval from 20 to 200 MeV. The average cross-section over this energy interval is 14.5 ± 2.2 millibarns. The differential cross-section appears to be due predominantly to S-wave scattering. The data obtained on inelastic collisions with complex nuclei were analysed by using an independent-particle model for the nucleus. Using this model and correcting for (a) nucleon shading, (b) Coulomb repulsion, (c) Pauli exclusion principle, and (d) repulsive potentials, , the authors obtained the average K–nucleon cross-section as a function of energy. This cross-section appears energy-independent in the energy interval 60 to 180 MeV. The values for the elementary cross-sections obtained in this analysis for $T_K = 60$ to 180 MeV with $V = V_N + V_C = 35$ MeV were $\bar{\sigma}$ (the average K–nucleon cross-section) = 11.8 ± 1.3 millibarns, $\sigma_{KN} = 9.8 \pm 3.0$ millibarns (with $\sigma_{Kn} = \sigma_{n^+} + \sigma_{n^0}$, where σ_{n^+} is direct neutron scattering and σ_{n^0} is charge-exchange scattering), $\sigma_{n^+} = 5.8 \pm 3.1$ millibarns, and $\sigma_{n^0} = 4.0 \pm 0.8$ millibarns. In this case the ratio $\sigma_{Kp} : \sigma_{n^+} : \sigma_{n^0} \cong 3.6 : 1.5 : 1$. A backward peaking was observed in the differential cross-section, due to a small P-wave contribution. These results lead the authors to believe that the K–nucleon scattering is a short range force interaction and does not proceed through single π-meson exchange. The latter would require high-angular-momenta contributions and would presumably result in a strongly energy-dependent cross-section. A repulsive potential was necessary to explain the behaviour of the fractional energy loss as a function of energy. The magnitude of the potential necessary for a best fit $V \cong 30$ MeV agrees very well with the results of a partial wave analysis of the elastic-scattering data.

539.12 : 539.14

553. HYPERONS AND HYPERFRAGMENTS. B.Jongejans.
Ned. Tijdschr. Natuurkde, Vol. 23, No. 12, 309-26 (Dec., 1957). In Dutch.

The recent history of fundamental nuclear particles is briefly reviewed and attention directed to the discovery of the short-lived hyperon and its associated hyperfragments. Conservation laws are discussed including the concept of "strangeness". An extensive bibliography is included. A.E.I. Research Laboratory

539.12

554. POSSIBLE DETERMINATION OF THE SPIN OF Λ^0 FROM ITS LARGE DECAY ANGULAR ASYMMETRY.
T.D.Lee and C.N.Yang.
Phys. Rev., Vol. 109, No. 5, 1755-8 (March 1, 1958).

General consideration of the angular distribution of the decay products of a hyperon into a pion and a nucleon is carried out for arbitrary values J of the hyperon spin. Limitations on the magnitude of the asymmetry in the angular distribution are found. These limitations are formulated in terms of certain test functions which when applied to experimental results may lead to an unambiguous determination of the values of the hyperon spin. These considerations and the large "up-down" asymmetry in Λ^0 decay reported in recent literature suggest that the spin of Λ^0 is $\frac{1}{2}$.

539.12

555. ON THE INTERACTION OF Ξ^--HYPERONS WITH NUCLEONS AND LIGHT NUCLEI.
L.B.Okun', I.Ya. Pomeranchuk and I.M.Shmushkevich.
Zh. éksper. teor. Fiz., Vol. 34, No. 5, 1246-9 (1958). In Russian.

Spin correlations are determined for Λ-particles produced in the $\Xi^- + p \rightarrow \Lambda + \Lambda$ proton absorption reaction (slow Ξ^-). An experimental study of such correlations should permit one to establish the parity of Λ-particles.

539.12

556. POLARIZATION EFFECTS IN Σ^- CAPTURE.
A.Pais and S.B.Treiman.
Phys. Rev., Vol. 109, No. 5, 1759-62 (March 1, 1958).

The interaction of very slow, or captured, polarized Σ^- hyperons with protons, $\Sigma^- + p \rightarrow \Lambda^0 + n$, may be used to yield information concerning the parity of Σ relative to Λ, the (Σ,Λ) parity. A qualitative distinction between even and odd parity depends on whether or not the polarization of the emergent Λ's varies with angle of emission. In order to determine the parity unambiguously it would furthermore be necessary to know whether the reaction proceeds from an initial S or P state. Aside from these questions, the polarization of the emergent Λ's serves as a detector of the initial Σ polarization. For example, if Σ's produced under given circumstances do not show an appreciable up-down asymmetry in decay, the above reaction might help to decide whether this is due to negligible polarization of the Σ^- in production.

539.12

557. HYPERON POLARIZATION IN ASSOCIATED PRODUCTION AND HEAVY MESON PARITY. D.Amati and B.Vitale.
Nuovo Cimento, Vol. 9, No. 2, 340-2 (July 16, 1958).

Measurement of the hyperon polarization in the reactions $\pi + N \rightarrow H + K$ is suggested as a test of the relative parities of hyperons and K-mesons. R.J.N.Phillips

539.12 : 537.591.15

558. OBSERVATION OF DECAYS OF CHARGED PARTICLES IN A DOUBLE [WILSON] CLOUD CHAMBER.
Z.Sh.Mandzhavidze, N.N.Roĭnishvili and G.E.Chikovani.
Zh. éksper. teor. Fiz., Vol. 34, No. 5, 1110-15 (1958). In Russian.

Ten events observed in a cloud chamber, of the decay of unstable charged particles produced in penetrating showers by cosmic rays at an altitude of 1800 m above sea level are analysed. $V^\pm$ decays are divided into two groups depending on the place of generation. The upper limit of the mean lifetime for one of these groups is estimated to be $\tau \leq (1.44 \pm 0.83) \times 10^{-10}$ sec. An anomalous decay is considered which cannot be explained on basis of the K-particle or hyperon decay schemes existing at present.

539.12

559. DETERMINATION OF THE PARITIES OF STRANGE PARTICLES FROM DISPERSION RELATIONS. S.Barshay.
Phys. Rev. Letters, Vol. 1, No. 5, 177-9 (Sept. 1, 1958).

This is a discussion of the extent to which the relative K–Λ–Σ parities can be deduced by a simple use of K–N scattering dispersion relations. J.C.Taylor

539.12

560. THE PHENOMENA OF EXCITATION AND IONIZATION BY α-PARTICLES. F.Grard.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 42, No. 7, 790-801 (1956). In French.

A theoretical study of excitation and ionization by α-particles. References are made to, and comparisons drawn with, the work of Levinger and Schwartz. J.D.Craggs

NUCLEUS

539.14

561. NUCLEAR PROPERTIES AND TWO-BODY FORCES. II. K.Wildermuth.
Fortschr. Phys., Vol. 5, No. 10-11, 469-516 (1957). In German.

For Pt I, see Fortschr. Phys., Vol. 5, 421-68 (1957). An integrating paper which deals with the following topics: two-nucleon interaction forces; saturation of nuclear forces; the potential constants of the optical model; binding and excitation energies of light nuclei; shell model; collective motions; Brueckner's theory of nuclear forces. P.Roman

U OF I

539.14 : 539.17

562. OXYGEN DIFFERENTIAL NEUTRON SCATTERING AND PHENOMENOLOGICAL NUCLEAR POTENTIALS.
J.L.Fowler and H.O.Cohn.
Phys. Rev., Vol. 109, No. 1, 89-93 (Jan. 1, 1958).

The neutron differential elastic scattering cross-section of O^{16} was measured at and in the vicinity of the 1 MeV resonance as well as at higher nonresonant energies. A phase-shift analysis of the results gives the $s_{1/2}$, $p_{1/2}$, $p_{3/2}$, and $d_{3/2}$ phase shifts up to 2.4 MeV neutron bombarding energy. The bound single-particle states of O^{17}, as well as the s- and d-wave phase shifts, determine the parameters of a phenomenological potential well which describes the average interaction of the neutron with the O^{16} core. This potential has a depth around 40-45 MeV, which varies slightly for different single-particle configurations, and has a diffuse boundary with a Thomas-type spin-orbit energy term. It is consistent with the potentials which in other work are found to fit data of much higher mass.

539.14 : 530.145

563. SEMI-PHENOMENOLOGICAL THEORY OF NUCLEON–NUCLEON INTERACTION. G.F.Zharkov.
Zh. eksper. teor. Fiz., Vol. 34, No. 5, 1211-20 (1958). In Russian.

Results of calculation of nucleon–nucleon interaction potentials are presented which are carried out within the framework of the semi-phenomenological isobar theory. The computed deuteron parameters and scattering of low-energy nucleons are found to agree satisfactorily with experiment. No success was encountered when the computed potentials were employed to describe the scattering of high-energy nucleons (~ 100 MeV).

539.14

564. SHORT RANGE FORCES AND NUCLEAR SHELL THEORY. M.Moshinsky.
Nuclear Phys., Vol. 8, No. 1, 19-40 (Sept. [1], 1958).

A procedure is developed for obtaining, in nuclear shell theory, the matrix elements associated with short-range interactions between nucleons. It is shown that potentials of arbitrary range, both central and spin dependent, can be developed in terms of a series of velocity dependent potentials in increasing powers of the momentum, but all of zero range. The coefficients of the terms in this series are the successive moments of the potential; thus, for short range forces, only the first few terms of the series will be relevant. All the matrix elements are obtained for two nucleons in the same shell and in LS coupling, up to terms containing the first moment of the potential. The matrix elements are compared for central, spin–orbit coupling and tensor forces, taking for the interaction potential between nucleons, a value that has been proposed recently.

539.14

565. PROPOSED BOUNDARY CONDITION POTENTIAL FOR THE TWO-NUCLEON PROBLEM. S.A.Moszkowski and B.L.Scott.
Phys. Rev. Letters, Vol. 1, No. 8, 298-300 (Oct. 15, 1958).

Having in mind application to the Brueckner theory of many-body systems, the authors propose to replace the hard core in the nucleon–nucleon potential by a boundary condition. They present numerical results where the free scattering S-phase shift of a core + an attractive square-well is well reproduced by replacing the core by a boundary condition at about twice the core radius, and changing somewhat the attractive part. The agreement is excellent up to 250 MeV. [But it should be noticed that one effect of the Pauli principle in nuclear matter is to introduce a non-local potential and that therefore two "equivalent potentials" for the case of free scattering could give different results in the many-body problem].
J.Lascoux

539.14

566. ON THE FOUNDATION OF THE OPTICAL NUCLEAR MODEL. P.Mittelstaedt.
Z. Naturforsch., Vol. 12a, No. 9, 675-8 (1957). In German.

The Goldberger and Brueckner–Watson methods of deriving the imaginary part of the optical model potential are compared and discussed.
R.J.N.Phillips

539.14

567. MASS ASSIGNMENTS OF 23 SEC Pd^{107m} AND 4.8 MIN Pd^{109m}; SEARCH FOR < 3 SEC Pd^{105m}. U.Schindewolf.
Phys. Rev., Vol. 109, No. 4, 1280-1 (Feb. 15, 1958).

The formation of the 23 sec and 4.8 min Pd isomers by neutron activation of Pd^{106} and Pd^{108} samples leads to the mass assignments 23 sec Pd^{107m} and 4.8 min Pd^{109m}. Both isomers decay by isomeric transition with considerable conversion only and are not formed in the β-decay of the corresponding Rh isotopes. The spin assignments (11/2–) could be confirmed. No isomeric state of Pd^{105} was found, and it is concluded that its half-life will be shorter than 3 sec.

539.14

568. SPIN–ORBIT INTERACTION IN NUCLEI.
B.P.Nigam and M.K.Sundaresan.
Canad. J. Phys., Vol. 36, No. 5, 571-8 (May, 1958).

Brueckner's theory of nuclear structure is used to estimate the spin–orbit interaction of a single nucleon interacting with the core arising from the tensor force of the two-body interaction. Using Yamaguchi's separable two-body interaction, the doublet splitting for Ca^{41} and O^{17} is calculated (1) in the first Born approximation, and (2) with an exact solution of the reaction matrix in which the exclusion principle has been taken into account. It is found that the values of the splittings calculated exactly are smaller than the experimental values.

539.14

569. SPINS OF SOME RADIOACTIVE IODINE ISOTOPES.
H.L.Garvin, T.M.Green and E.Lipworth.
Phys. Rev., Vol. 111, No. 2, 534-9 (July 15, 1958).

The spins of I^{123}, I^{124}, and I^{131} were measured by the method of atomic beams; the spins are $\frac{5}{2}$, 2, and $\frac{7}{2}$, respectively. The result $I = \frac{7}{2}$ for I^{131} confirms an earlier measurement by a different method.

539.14

570. SPIN OF Fe^{57}. G.W.Ludwig, H.H.Woodbury and R.O.Carlson.
Phys. Rev. Letters, Vol. 1, No. 8, 295-6 (Oct. 15, 1958).

The electron spin resonance of silicon crystals doped with iron includes a hyperfine doublet when the iron is enriched to contain 84.1% Fe^{57}. The nuclear spin of Fe^{57} is thus confirmed as $\frac{1}{2}$.
E.F.W.Seymour

539.14 : 539.12

571. ELECTRON SCATTERING AND NUCLEAR CHARGE DISTRIBUTIONS. D.G.Ravenhall.
Rev. mod. Phys., Vol. 30, No. 2(I), 430-8 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). Electron scattering experiments are examined for each region of the periodic table, in relation with the corresponding appropriate nuclear model. This allows "accurate determination of some of the relevant parameters" of the model used. J.Lascoux

539.14 : 539.18

572. NUCLEAR RADII FROM MESONIC ATOMS. E.M.Henley.
Rev. mod. Phys., Vol. 30, No. 2(I), 438-41 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). The X-ray transition 2P-1S of a μ-meson determines "unambigously but a single parameter", usually the radius of the proton density. But the author, after surveying the data so far obtained, points out that more precise experiments will give considerably more information about the electromagnetic structure of the nucleus, in particular concerning nuclear polarization and compressibility.
J.Lascoux

539.14 : 539.12

573. ELECTROMAGNETIC STRUCTURE OF THE PROTON AND NEUTRON. R.Hofstadter, F.Bumiller and M.R.Yearian.
Rev. mod. Phys., Vol. 30, No. 2(I), 482-97 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). A careful and exhaustive description of how the high-energy electron scattering experiments are analysed to provide information about the spatial distributions of the neutron and proton charges and magnetic moments. Theoretical fundamentals are used in a simple fashion.
G.E.Brown

539.14

574. ANGULAR SHAPES OF NUCLEI. G.M.Temmer.
Rev. mod. Phys., Vol. 30, No. 2(I), 498-506 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). The main part of the paper is a review of the different experimental results concerning the electric quadrupole moment. Electric octupole moments are included in the survey, in connection with the experimental band of levels (1^-, 3^-, 5^-...) and also with the alpha-decay fine structure of heavy nuclei.
J.Lascoux

539.14 : 539.18

575. THEORY OF ISOTOPE SHIFT. G.Breit.
Rev. mod. Phys., Vol. 30, No. 2(I), 507-16 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). A detailed examination of all the assumptions underlying the theoretical evaluation of the isotope shift. In the concluding remarks, "the schematic character of the treatment of the nucleus" is stressed, and a more careful examination of the changes in the nuclear wave-function resulting from the addition of a neutron called for.
J.Lascoux

539.14 : 537.531

576. NUCLEAR SIZE ESTIMATES FROM X-RAY FINE STRUCTURE MEASUREMENTS. R.L.Shacklett.
Rev. mod. Phys., Vol. 30, No. 2(I), 521-7 (April, 1958).
"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). The effect of nuclear size on the $2p_{1/2}$ level of heavy elements is relatively small. If one assumes a uniform charge distribution of radius $R = 1.2 \times 10^{-13} A^{1/3}$, comparison of the measured fine-structure with theoretical values corrected for nuclear size and vacuum polarization indicates that the Lamb shift has "a very strong Z-dependence, similar to that of the vacuum polarization, and opposite in sign". J.Lascoux

539.14

577. THEORIES OF THE NUCLEAR SURFACE. L.Wilets.
Rev. mod. Phys., Vol. 30, No. 2(I), 542-9 (April, 1958).
"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). A clear and comprehensive review article giving simple pictures of theories of the surface energy in nuclei. G.E.Brown

539.14

578. NUCLEAR RADII FROM ANTIPROTON MEASUREMENTS. E.Segrē.
Rev. mod. Phys., Vol. 30, No. 2(I), 550-2 (April, 1958).
"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). Scattering of antiprotons by nuclei is reviewed. Especial attential is paid to the large value of $p\bar{p}$ scattering compared with pp scattering and the theoretical explanation. G.E.Brown

539.14

579. RELATION OF NUCLEAR SIZE TO SATURATION AND NUCLEAR COMPRESSIBILITY. K.A.Brueckner.
Rev. mod. Phys., Vol. 30, No. 2(I), 561-5 (April, 1958).
"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). A simple discussion of the work by the author and collaborators to calculate the energy of nuclear matter. The finite nucleus and nuclear surface are also treated. G.E.Brown

539.14 : 539.12

580. IMPLICATIONS OF THE DIRECT-INTERACTION MODEL FOR NUCLEAR STRUCTURE. K.M.Watson.
Rev. mod. Phys., Vol. 30, No. 2(I), 565-8 (April, 1958).
"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). Applicability of the Serber-type model to high-energy scattering is surveyed. G.E.Brown

539.14

581. NUCLEAR SIZES AND THE WEISZÄCKER MASS FORMULA. A.E.S.Green.
Rev. mod. Phys., Vol. 30, No. 2(I), 569-84 (April, 1958).
"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). A review of semi-empirical mass formulae and the degree of success with which they describe experimental data. The Bethe–Weisz̈acker type mass surface provides its best account of nuclear masses for a Coulomb radius parameter in agreement with that inferred from electron scattering. Improvements, both in the form of fluctuating shell and pairing corrections and in smooth statistical corrections, are discussed. The second portion of the article is devoted to an effort to relate the Weisz̈acker equation directly to the potentials obtained from scattering and shell models. G.E.Brown

539.14 : 539.12

INTERPRETATION OF SCATTERING CROSS-SECTIONS IN TERMS OF NUCLEAR SIZE. See Abstr. 513

539.14

582. INVESTIGATION OF EXCITED STATES IN Be^8 BY ALPHA-PARTICLE SCATTERING FROM He.
R.Nilson, W.K.Jentschke, G.R.Briggs, R.O.Kerman and J.N.Snyder.
Phys. Rev., Vol. 109, No. 3, 850-60 (Feb. 1, 1958).
Partial phase shifts were deduced from the data on the scattering of α particles (12.3 to 22.9 MeV) from He. The monotonic decrease of the S-wave phase shift throughout the energy range investigated indicates no broad S states in Be^8 for excitations between 0.5 and 11.45 MeV. The D-wave phase-shift energy dependence clearly indicates the 2.9 MeV 2^+ state in Be^8. The G-wave phase-shift shows a broad 4^+ state in the neighbourhood of 11 MeV with a reduced width of about 2 MeV. The I-wave phase-shift is first observed at 20 MeV and is positive. Moderate success was achieved in explaining the scattering results in terms of Haefner's alpha-particle model of Be^8.

539.14 : 537.312.62

583. POSSIBLE ANALOGY BETWEEN THE EXCITATION SPECTRA OF NUCLEI AND THOSE OF THE SUPERCONDUCTING METALLIC STATE. A.Bohr, B.R.Mottelson and D.Pines.
Phys. Rev., Vol. 110, No. 4, 936-8 (May 15, 1958).
The evidence for an energy gap in the intrinsic excitation spectrum of nuclei is reviewed. A possible analogy between this effect and the energy gap observed in the electronic excitation of a superconducting metal is suggested.

539.14

584. NUCLEAR LEVEL SPACINGS. A.G.W.Cameron.
Canad. J. Phys., Vol. 36, No. 8, 1040-57 (Aug., 1958).
Newton's shell-dependent level spacing formula (Abstr. 7613/1956) depends upon the densities of single-particle orbits near the Fermi level in the nucleon gas. It was found that these densities can be computed by taking appropriate averages of the second differences between adjacent atomic masses, using the author's semi-empirical mass formula from which electrostatic and pairing energy terms are omitted. With this procedure, observed nuclear level spacings were fitted with a root mean square error factor of 1.74. This fit shows that the level spacings are proportional to $(2J + 1)^{-1}$ to a good approximation. Since the average density of single-particle orbits depends on the nuclear excitation energy (and since its computation takes a long time even with an electronic computer) an approximation formula with five coefficients was fitted to the computed orbit densities for each Z and N in the ranges $10 \leq Z \leq 109$ and $10 \leq N \leq 189$. These coefficiencies are tabulated.

539.14 : 539.17

585. ENERGY LEVELS OF Na^{23} FROM THE $Ne^{22}(p,\gamma)Na^{23}$ REACTION. D.E.J.Thornton, R.E.Meads and C.H.Collie.
Phys. Rev., Vol. 109, No. 2, 480-4 (Jan. 15, 1958).
The gamma-ray excitation function of the $Ne^{22}(p,\gamma)Na^{23}$ reaction for protons of energies in the range 500-900 keV was measured. Narrow resonances at 636, 660, 854, 901, 933 and 943 keV were observed in agreement with earlier workers. The 660 keV and 943 keV resonances may be due to contaminants, but the remainder were assigned unambiguously to the above reaction, and their gamma-ray spectra examined. A detailed study, including angular distribution measurements, was made of the resonances at 636 and 854 keV. In all four resonances ground-state radiation was observed, and in the upper three radiation to the first excited state was found. A cascade through the 3.92 MeV level was observed in the 854 keV resonance. The results suggest that the first excited state has spin $\frac{5}{2}$, even parity; the 3.92 MeV level, $\frac{5}{2}$ or $\frac{7}{2}+$; the 9.40 MeV capture state $\frac{1}{2}-$; and the 9.61 MeV capture state $\frac{3}{2}$, + or −.

539.14

586. F^{18} LEVELS NEAR 1 MeV.
J.A.Kuehner, E.Almqvist and D.A.Bromley.
Phys. Rev. Letters, Vol. 1, No. 7, 260-2 (Oct. 1, 1958).
The γ-rays from the reaction $N^{14}(\alpha, \gamma)F^{18}$ reaction were studied and it is shown that a level at 1.08 MeV is required in F^{18} in addition to those at 0.94, 1.04 and 1.120 MeV to explain the observed γ-ray energies. Measurements with a 180° magnetic spectrograph on the reaction $O^{16}(He^3,p)F^{18}$ corroborate the existence of these levels. L.L.Green

539.14

587. NUCLEAR MAGNETISM AND NUCLEAR RELAXATION. E.M.Purcell.
Nuovo Cimento Suppl., Vol. 6, No. 3, 961-92 (1957).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

539.14

588. INFLUENCE OF ELECTRONS ON NUCLEAR SPIN RESONANCE IN DIAMAGNETIC SUBSTANCES: CHEMICAL DISPLACEMENT AND INDIRECT INTERACTIONS. A.Abragam.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1015-62 (1957). In French.
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

539.14

589. INFLUENCE OF THE APPARATUS ON NUCLEAR MAGNETIC RESONANCE. H.Pfeifer.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1188-9 (1957).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

539.14 : 539.2

590. NUCLEAR MAGNETIZATION IN THE PRESENCE OF ULTRASONIC EXCITATION. O.Kraus and W.H.Tanttila.
Phys. Rev., Vol. 109, No. 4, 1052-8 (Feb. 15, 1958).
The field gradient at the site of a nucleus resulting from a

relative displacement of surrounding charge in a solid is expanded in a Taylor series. The resulting expression is used to calculate the transition probability induced by this displacement for transitions of quadrupolar nuclei between $\Delta m = \pm 2$ spin levels in a sodium chloride-type lattice. The equilibrium nuclear magnetization in the presence of ultrasonic and thermal lattice vibrations is derived on the assumption of fast mutual spin-flip processes. The derivation is also based on a strain-free lattice.

539.14 : 539.2

591. ULTRASONICALLY INDUCED SPIN TRANSITIONS IN SODIUM IODIDE. D.A.Jennings, W.H.Tanttila and O.Kraus.
Phys. Rev., Vol. 109, No. 4, 1059-62 (Feb. 15, 1958).

The authors examined the influence of ultrasonic vibrations on the nuclear magnetization of sodium and iodine nuclei in a single crystal of sodium iodide. The results support Sternheimer's calculations of quadrupole polarizability of ionic cores (Abstr. 4643/1957). In addition measurements made on the line-width of the ultrasonic excitation effective in bringing about nuclear spin transitions show that the line-width for iodine nuclei is narrower than the line-width for the sodium nuclei. These results appear somewhat anomalous in the light of previous explanations of Pound, Watkins, and Reif.

539.14

592. H.F.S. ANOMALY OF Sb^{121} AND Sb^{123} DETERMINED BY THE ELECTRON NUCLEAR DOUBLE RESONANCE TECHNIQUE. J.Eisinger and G.Feher.
Phys. Rev., Vol. 109, No. 4, 1172-83 (Feb. 15, 1958).

The ratios of the hyperfine interaction constants "a" (these constants are a measure of the strength of the interaction between the nuclear magnetic dipole moment and the moment due to the orbital electron) and the nuclear g-factors of the stable isotopes of antimony were measured. From these measurements the hyperfine structure anomaly, defined as $\Delta = (a_{121}/a_{123})(g_{123}/g_{121}) - 1$, was found to be $(-0.352 \pm 0.005)\%$. The quantity Δ has its origin in the difference in the spatial distribution of the nuclear magnetic dipole for the two isotopes, which is related to the structure of the two nuclei. The experimental result is compared with theoretical values of Δ based on a variety of nuclear models. The determination of a_{121}/a_{123} makes use of the electron nuclear double resonance technique which is discussed in some detail. The sample used in the experiment was silicon, doped with antimony and the microwave resonances were observed at ~ 9000 Mc/s at a temperature of 1.2°K. The ratio of the nuclear g factors was determined by conventional nuclear magnetic resonance technique.

539.14

593. THE NON-MESONIC DECAY IN FLIGHT OF A He HYPERFRAGMENT. M.B.Ceolin, W.F.Fry and H.Huzita.
Nuovo Cimento, Vol. 9, No. 3, 551-3 (Aug. 1, 1958).

An event in photographic emulsion is described.

J.M.Cassels

539.14 : 539.12

594. Λ-NUCLEON POTENTIAL FROM HYPERFRAGMENT DATA. M.Ross and D.B.Lichtenberg.
Phys. Rev., Vol. 110, No. 3, 737-42 (May 1, 1958).

The volume integrals of the Λ–nucleon potentials in the triplet and singlet spin states are deduced from hyperfragment binding-energy data. The effects of tensor forces are neglected in the calculation but are discussed qualitatively. Results are sensitive to the sizes and shapes of the nuclei in which the Λ is bound, but are not very sensitive to Λ binding energies. Results also depend on the range of the Λ–nucleon potential and on the spin configurations of the nuclei. Within the approximations made, the Λ–nucleon potentials are consistent with experiment and agree with theoretical potentials due to pion exchange. A crude determination of the Λ–nucleon potential from the observed lifetime for mesonic decay of hyperfragments is consistent with the binding-energy determination.

539.14 : 539.12

HYPERONS AND HYPERFRAGMENTS. See Abstr. 553

RADIOACTIVITY

539.16.08 : 539.1.07

SOME METHODS IN NUCLEAR SPECTROSCOPY AND THEIR APPLICATION TO THE STUDY OF Sc^{48} AND V^{48}. See Abstr. 489

539.163

595. ON THE PRODUCTION OF RADIOACTIVITY IN ROCKS BY COSMIC RAYS. L.Marquez and N.L.Costa.
An. Acad. Brasil. Cienc, Vol. 29, No. 2, 225-7 (1957).

Reports failure to detect Be^{10} in 55 kg of limestone.

E.J.Burge

539.163

596. EVIDENCE FOR THE FORMATION OF LONG-LIVED Bi^{208} BY THE (n,2n) REACTION ON BISMUTH.
J.C.Roy, T.A.Eastwood and R.C.Hawkings.
Canad. J. Phys., Vol. 36, No. 1, 18-24 (Jan., 1958).

Long-lived Bi^{208} was observed through its decay by electron capture to the first excited state of Pb^{208} at 2.61 MeV. It has been produced by the (n,2n) reaction on Bi^{209}. The half-life of Bi^{208} was estimated to be 3×10^4 years, with an uncertainty of a factor of about 2.

539.163

597. NUCLEAR SPECTROSCOPY OF NEUTRON-DEFICIENT RARE EARTHS (Tb THROUGH Hf).
J.W.Mihelich, B.Harmatz and T.H.Handley.
Phys. Rev., Vol. 108, No. 4, 989-99 (Nov. 15, 1957).

A survey was made of electron-capturing nuclides produced by irradiating rare earths (Gd to Hf) of various isotopic enrichments with 22 MeV protons. Ion-exchange chemistry was performed, conversion-electron spectra were analysed and the various activities catalogued. At least ten new activities, Tb^{153}, Tb^{155}, Tb^{156m}, Dy^{155} Ho^{156}, Ho^{160m}, Ho^{162}, Er^{158m}, Yb^{171m}, and Lu^{169} were found and studied. Eighteen previously known activities also were examined. Multipolarities consistent with the observed conversion electron intensity ratios are proposed. The positions of levels of even–even nuclei as a function of both proton and neutron number are discussed.

539.163 : 539.14

598. NEPTUNIUM ISOTOPES: 234, 235, 236.
J.E.Gindler, J.R.Huizenga and D.W.Engelkemeir.
Phys. Rev., Vol. 109, No. 4, 1263-7 (Feb. 15, 1958).

Neptunium isotopes of mass numbers 234, 235 and 236 were produced by an 18 MeV deuteron bombardment of uranium highly enriched in U^{235}. The radiations of Np^{235} were studied with scintillation and proportional counters in singles and coincidence. The L/K and M/L electron-capture branching ratios of Np^{235} were measured to be 36.7 and 0.46 respectively. From the L/K ratio, the calculated decay energy of Np^{235} is 123 keV. An upper limit of 2.1% of the Np^{235} electron-capture disintegrations populate excited states of U^{235}. The experimental data favour a spin of 5/2 for Np^{235}. The alpha to electron capture ratio for Np^{235} is 1.59×10^{-5}, giving a partial alpha half-life of 7.0×10^4 years. The long-lived isomer of Np^{236} was produced in the bombardment, but no isomer of Np^{234} with half-life longer than two months was observed in a mass-spectrometer analysis of the neptunium sample.

539.163

599. ADDITIONAL DATA ON THE RADIOACTIVE DECAY OF Ho^{166} (27 HR), Nd^{147}, AND Sm^{153}.
J.M.Cork, M.K.Brice, R.G.Helmer and R.M.Woods, Jr.
Phys. Rev., Vol. 110, No. 2, 526-8 (April 15, 1958).

By using chemically pure Ho^{165} and enriched isotopes of Nd^{146} and Sm^{152}, high-activity samples of Ho^{166}, Nd^{147} and Sm^{153} were made by neutron capture. Studies of the strong sources by both magnetic and scintillation spectrometers showed the existence of some gamma rays not previously reported, yielded more exact energy values for the low-energy gamma rays, and made possible better resolution of the components of the beta spectra. In Ho^{166}, gamma rays occur at 80.25, 970, 1377, 1540 and 1620 keV, and the maximum beta energies are 1839, 1756, 869, 412 and 230 keV. Nd^{147} yields gamma rays at 91.3, 120.6, 198.2, 277, 321, 400, 441, 533 and 688 keV, with beta components at 812, 380 and 230 keV. In Sm^{153} gamma rays are found at 69.8, 103.5, 173.6 and 540 keV and beta components at 813, 710, and 640 keV. A level scheme in agreement with the observed data is presented for each nucleus.

539.163

600. DECAY OF Tc^{97} GROUND STATE. S.Katcoff.
Phys. Rev., Vol. 111, No. 2, 575-8 (July 15, 1958).

The half-life of the ground state of Tc^{97} was found to be $(2.6 \pm 0.4) \times 10^6$ years by comparison of its K X-ray intensity with that from the 90-day Tc^{97m} isomeric state. The L/K-capture ratio of Tc^{97} was compared with that of Tc^{96}; a somewhat larger ratio is indicated for the former. No γ-rays were observed that could be attributed to Tc^{97}. The relation of these results to the occurrence of technetium in certain stars and to its possible occurrence in the earth's crust is discussed. Improved measurements of the Tc^{98} γ-rays energies yielded values of 669 ± 5 keV and 769 ± 6 keV.

539.163.1 : 539.14

601. MASS, HALF-LIFE, AND EXCITED STATES OF B^8.
K.L.Dunning, J.W.Butler and R.O.Bondelid.
Phys. Rev., Vol. 110, No. 5, 1076-9 (June 1, 1958).

The mass of B^8 was determined by measuring the threshold energy of the reaction $Li^6(He^3,n)B^8$. Observations were made on both the neutrons from the reaction and the positrons from the decay of B^8. The threshold energy is 2.9661 ± 0.0017 MeV, giving a mass of 8.027157 ± 0.000008 a.m.u. for B^8. The half-life was measured to be 0.78 ± 0.01 sec. Evidence was found for possible excited states in B^8 at 0.6 ± 0.1 and 0.80 ± 0.05 MeV with respective widths of 0.2 ± 0.1 and 0.07 ± 0.04 MeV. Assuming that the decay proceeds exclusively to the 2.9 MeV state of Be^8, the log (ft) value is 5.7.

539.163.1

602. LIFETIME OF THE 473 keV LEVEL IN Tm^{169}.
E.N.Hatch and D.E.Alburger.
Phys. Rev., Vol. 110, No. 5, 1116-18 (June 1, 1958).

The investigation was made by means of an intermediate-image beta-ray spectrometer, which was arranged for observing beta-gamma coincidences with a fast-slow coincidence system. From the distribution of delayed coincidences between 94 keV L-conversion electrons and K-capture X-rays, an upper limit for the half-life of the 473 keV level of 3×10^{-9} sec is assigned. It is concluded that the rotational interpretation for this level is most likely the correct one.

539.163.2

603. ON THE DECAY OF Bi^{204}.
R.Stockendal, T.Novakov, B.Johansson and M.Schmorak.
Ark. Fys., Vol. 14, Paper 6, 65-84 (1958).

Energy levels in Pb^{204} were studied in the electron capture decay of 12 hr Bi^{204}. 45 transitions and, in addition, about 20 weak, unassigned conversion lines were found in this very complex decay. Energies and intensities of conversion lines were measured in permanent magnet and double-focusing spectrometers. Relative gamma intensities were obtained by use of a scintillation spectrometer. Electron–gamma and gamma–gamma coincidence measurements were performed with instruments including a 100-channel pulse-height analyser. A tentative decay scheme is discussed.

539.163.2

604. ON THE DECAY OF Bi^{203}.
T.Novakov, R.Stockendal, M.Schmorak and B.Johansson.
Ark. Fys., Vol. 14, Paper 7, 85-99 (1958).

The level scheme of Pb^{203} was studied in the decay of 12 hr Bi^{203}. 20 transitions were found. The experiments included energy and intensity measurements on conversion lines in permanent magnet and double-focusing spectrometers, measurements of relative gamma intensities in a scintillation spectrometer, electron–gamma and gamma–gamma coincidence measurements using a 100-channel pulse-height analyser. Positrons were discovered; from studies in an intermediate-image beta-spectrometer, and in a double-focusing spectrometer the positron emission was resolved in two components, 740 ± 50 keV and 1350 ± 50 keV. A decay scheme is suggested.

539.163.2

605. THE DECAY SCHEME OF Os^{193} BY FAST $\beta-\gamma$ AND $\gamma-\gamma$ COINCIDENCES. L.Feuvrais and M.Spighel.
C.R. Acad. Sci. (Paris), Vol. 247, No. 3, 287-90 (July 21, 1958).
In French.

The half-lives of levels excited in Ir^{193} by β-decay of Os^{193} were found by delayed coincidence measurements to be less than 10^{-9} sec for those at 558, 460 and 280 keV, 6.2×10^{-9} sec for that at 73 keV, and $(1.05 \pm 0.25) \times 10^{-9}$ sec for that at 139 keV. M.A.Grace

539.163.2

606. MASS ASSIGNMENT OF THE 1.8 HOUR YTTERBIUM ACTIVITY. R.H.Betts, O.F.Dahlinger and D.M.Munro.
Canad. J. Phys., Vol. 36, No. 1, 73-81 (Jan., 1958).

The rate of growth of Lu^{177} into neutron-irradiated ytterbium was measured by radioassay of lutetium fractions separated by ion-exchange techniques. Such measurements show the parent of Lu^{177} to be the 1.8 hr Yb; this latter nuclide is therefore Yb^{177}. Confirmatory values of 3.71 ± 0.04 hr and 6.75 ± 0.05 days were obtained for the half-lives of Lu^{176m} and Lu^{177}.

539.163.2

607. BRANCHING RATIO OF ThC (^{212}Bi).
D.Prosperi and S.Sciuti.
Nuovo Cimento, Vol. 9, No. 4, 734-5 (Aug. 16, 1958).

A 2π gridded ionization chamber was used to compare the ThC and ThC′ α-activities from which a value of 0.352 ± 0.003 was obtained for the branching ratio of $\alpha/(\alpha + \beta)$. M.A.Grace

539.163.2

608. DECAY OF COPPER-66. D.J.Horen and W.E.Meyerhof.
Phys. Rev., Vol. 111, No. 2, 559-61 (July 15, 1958).

The decay of Cu^{66} (5.1 min) was reinvestigated by scintillation spectroscopy. A (0.83 ± 0.01) MeV gamma-ray was found to be in coincidence with the previously known 1.04 MeV gamma-ray arising from the decay of the first excited state in Zn^{66}. This indicates a (second) excited state in Zn^{66} at 1.87 MeV in line with the level systematics of neighbouring Zn isotopes.

539.163.2

609. THE DECAY SCHEME OF Ag^{105}. M.Raether.
Z. Phys., Vol. 150, No. 1, 38-48 (1958). In German.

This was investigated using a scintillation spectrometer. A level scheme is given. A.O.Stanesby

539.164

610. HIGH-ENERGY ALPHA PARTICLES FROM B^{12}.
C.W.Cook, W.A.Fowler, C.C.Lauritsen and T.Lauritsen.
Phys. Rev., Vol. 111, No. 2, 567-71 (July 15, 1958).

An earlier investigation of the alpha-particle spectrum associated with the beta decay of B^{12} is extended to an alpha-particle energy of approximately 3 MeV. The high-energy spectrum appears to indicate a broad level in C^{12} having an excitation energy of 10.1 ± 0.2 MeV and a width at half-maximum of $\Gamma \cong 2.5$ MeV. The most probable spin and parity assignment for this level is $J = 0^+$, although $J = 2^+$ cannot be definitely excluded; for $J = 0^+$ the width is approximately the Wigner limit. It is found that (0.13 ± 0.04)% of all decays of B^{12} lead to this state.

539.164

611. ANGULAR CORRELATION OF ALPHA PARTICLES FROM THE DECAY OF Li^8.
T.Lauritsen, C.A.Barnes, W.A.Fowler and C.C.Lauritsen.
Phys. Rev. Letters, Vol. 1, No. 9, 326-8 (Nov. 1, 1958).

It is shown from the results that Li^8 has spin and parity 2+ and that the β-decay interaction is at least 90% Gamow–Teller. C.J.Batty

539.164.07 : 539.1.07

DETECTION OF ALPHA PARTICLES WITH ZnS SCINTILLATORS. See Abstr. 493

539.164.2

612. ALPHA DECAY OF SPHEROIDAL NUCLEI.
E.M.Pennington and M.A.Preston.
Canad. J. Phys., Vol. 36, No. 7, 944-62 (July, 1958).

A system of coupled differential equations relates the amplitudes of alpha particle waves emitted from a spheroidal nucleus described by the Bohr–Mottelson model. These equations in spheroidal coordinates were solved for five even–even nuclides with the aid of an electronic computer. There are four possible cases for each nuclide which are consistent with the boundary conditions. The solutions of the equations are used to calculate the probability density of alpha particles on the nuclear surface for each case. For Case 1 the peak in the distribution function shifts from the nuclear symmetry axis to the equator with increasing mass number. The probability density for Case 2 is always peaked between the symmetry axis and the equator, while for Cases 3 and 4 it is always peaked strongly at the equator. The change in the distribution function with increasing distance from the nucleus is considered for a typical case. Barrier penetration factors are calculated and found to differ from those for spherical nuclei by factors of the order of 2 or 3. Comparison with the calculations of an approximation method of Frŏman is made for one nuclide.

539.164.2

613. NUMERICAL SOLUTIONS OF THE CURIUM 242 ALPHA-DECAY WAVE EQUATION. J.O.Rasmussen and E.R.Hansen.
Phys. Rev., Vol. 109, No. 5, 1656-63 (March 1, 1958).

Numerical integration of the previously derived alpha-decay wave equation, including electric quadrupole coupling terms, was carried out for Cm^{242} including $l = 0, 2, 4$, and 6 partial waves. Eight integrations were carried inward in spherical polar coordinates on an IBM-650 computer with different initial conditions, such that a complete set of eight linearly independent solutions to the system of coupled equations was generated. Eight different linear combinations of this base set were found which satisfy the boundary conditions imposed by experimental Cm^{242} alpha-group intensities. Wave amplitudes on a spherical surface near the nucleus are given for all eight cases, and the radial variation throughout the barrier region is given for two cases. The matrix formalism of Frŏman is employed in another presentation of the results, and a comparison is made with the analogous Frŏman matrix. By using a modified Frŏman matrix together with the present results, the alpha-wave

distributions are calculated for a spheroidal nuclear interaction surface. A discussion is made of conditions for the existence of solutions satisfying boundary conditions imposed by alpha-group intensities, and the quadrupole phase shift problem is considered.

539.165 : 539.164

614. BETA-NEUTRINO–ALPHA DIRECTIONAL CORRELATION. M.Morita.
Phys. Rev. Letters, Vol. 1, No. 3, 112-14 (Aug. 1, 1958).

The correlation function is given explicitly and reduced to a form suitable for the interpretation of the Li^8 $(\beta)Be^{8*}(\alpha)He^4$ correlation experiment of Lauterjung, Schimmer and Maier-Leibnitz (Z. Phys., to be published). M.A.Grace

539.165

615. K-CAPTURE–POSITRON RATIOS FOR FIRST-FORBIDDEN TRANSITIONS: Sb^{122}, Rb^{84}, I^{126}, As^{74}.
M.L.Perlman, J.P.Welker and M.Wolfsberg.
Phys. Rev., Vol. 110, No. 2, 381-92 (April 15, 1958).

The theory for the relative probabilities of K-electron capture and of positron emission is reinvestigated in the cases of allowed and first-forbidden transitions. Effects of screening and of finite nuclear size are discussed and calculated. Careful comparison is made between theory and available experimental results for allowed and "unique" first-forbidden transitions; details and results of a new measurement for the transition $Sb^{122} \rightarrow Sn^{122}$ ($\Delta J = 2$,yes) are presented. Other types of first-forbidden transitions are analysed in terms of the relative contributions of the various matrix elements which appear in the interaction combinations, S,T,P and V,A; and the experimental results for the $\Delta J = 0$,yes transitions in As^{74}, Rb^{84}, and I^{126} are discussed. Simple formulae are presented for the evaluation of the coefficients of the several matrix elements.

539.165 : 539.166

616. A CONTRIBUTION TO THE STUDY OF BETA–GAMMA ANGULAR CORRELATION. P.Macq.
Mem. Acad. Roy. Belgique Cl. Sci. (Coll. in 8°), Vol. 30, No. 1, 36 pp. (1956). In French.

A full account of $\beta-\gamma$ correlation measurement on Cl^{38}, Rb^{86} and Co^{60}. M.A.Grace

539.165 : 539.166.83

617. ELECTRIC MONOPOLE TRANSITIONS IN Ge^{70} AND Zr^{90}.
D.E.Alburger.
Phys. Rev., Vol. 109, No. 4, 1222-9 (Feb. 15, 1958).

The electric monopole crossover transition from the 1.215 MeV 0_+ second excited state to the ground state of Ge^{70} was observed with an intermediate-image beta-ray spectrometer arranged for electron–electron coincidence measurements. Internal conversion electrons in delayed coincidence with Ga^{70} beta-rays correspond to a 1.215 MeV transition intensity of 0.0025% per disintegration. Total beta-ray branching to the 1.215 MeV state is 0.18%, mostly followed by a (0.173 ± 0.002)–(1.042 ± 0.005) MeV gamma-ray cascade through the first excited state. Beta-ray branching to the 1.042 MeV level in Ge^{70} is 0.30%. Beta–conversion-electron delayed coincidence measurements taken at the peak of the 0.173 MeV K-line give a half-life value of $(3.0 \pm 0.5) \times 10^{-9}$ sec for the 1.215 MeV state. It follows that the partial half-life for K-conversion of the 0–0 transition is $(2.4 \pm 1.2) \times 10^{-7}$ sec which compares with 1.6×10^{-7} sec which compares with 1.6×10^{-7} sec expected if the matrix element were the same as for the 0–0 transition in Ge^{72}. Using similar techniques on Y^{90}, the half-life of the 1.75 MeV 0–0 transition in Zr^{90} was found to be $(6 \pm 1.5) \times 10^{-8}$ sec.

539.165 : 539.166

618. TIME-REVERSAL INVARIANCE AND BETA–GAMMA ANGULAR CORRELATION. II. M.Morita and R.S.Morita.
Phys. Rev., Vol. 110, No. 2, 461-5 (April 15, 1958).

For previous part, see Abstr. 2545 (1958). The angular-correlation between beta and gamma-rays from oriented nuclei (with or without observation of circular polarization) is given for use in testing the invariance property of the beta interactions under time reversal. The formulae are derived in the cases where the beta decay is an allowed or first forbidden transition and the gamma-ray has a mixture of arbitrary multipolarities. A general form for the $\beta-\gamma_1-\gamma_2$ angular correlation in triple cascade transitions of unoriented nuclei is also shown. It does not give clear-cut information on the invariance property of beta interactions under time reversal. The correlation functions where gamma-rays are replaced by alpha particles are discussed in the above two cases. The beta–alpha directional correlation from oriented nuclei may be useful in testing the invariance property of beta interactions under time reversal.

539.165 : 539.166

619. ELECTRON-CAPTURE DECAY OF Pu^{237}.
D.C.Hoffman and B.J.Dropesky.
Phys. Rev., Vol. 109, No. 4, 1282-90 (Feb. 15, 1958).

The conversion and K-Auger electron spectra of Pu^{237} (produced by alpha-bombardment of U^{235}) were examined with a permanent-magnet spectrograph and a solenoidal beta-ray spectrometer. The photon spectrum was studied with scintillation spectrometers and the following intensity ratios were determined: K X-radiation : L X-radiation : 59.6 keV gamma-radiation = 1.00 : 0.75 : 0.14. Data from the beta-ray and scintillation spectrometers were used to calculate a K-Auger electron coefficient of 0.06 ± 0.01 for Z = 93. Coincidence measurements established the existence of both K- and L-electron capture to the 59.6 keV level of Np^{237}. The ratio of L- to K-capture to that level was found to be 2.8, and from this ratio a total electron-capture decay energy of 0.21 MeV was calculated for Pu^{237}. This value is in good agreement with that of 0.22 MeV estimated from closed decay-energy cycles. The experimental data indicate that the principal branches of electron-capture decay are to the 59.6 keV (15%) and the 33.2 keV (22%) levels, and to the ground state (60%) of Np^{237}, with corresponding log ft values of 6.8, 6.9, and 6.8, respectively.

539.165

620. THE L/K-CAPTURE RATIO IN ^{126}I.
J.Scobie and E.Gabathuler.
Proc. Phys. Soc., Vol. 72, Pt 3, 437-40 (Sept., 1958).

A direct measurement was made of the relative intensities of the L and K X-radiations emitted in the electron capture decay of I^{126}. The source was distributed throughout the central portion of the NaI crystal in which the X-radiations were measured, and coincidences were taken with the gamma rays from the excited states. The L/K-capture ratio was observed to be $0.142^{+0.005}_{-0.018}$, which is close to the theoretical value of 0.126.

539.165 : 539.12

621. BETA-DECAYS AND TIME REVERSAL. J.Wrzecionko.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 6, 387-93 (1958).

The adequacy of tests for time reversal violation is discussed in a general way, the importance of the hermiticity of the transition matrix being stressed. J.C.Taylor

539.165

622. SHAPE AND POLARIZATION OF THE BETA SPECTRUM OF RADIUM E. A.Bincer, E.Church and J.Weneser.
Phys. Rev. Letters, Vol. 1, No. 3, 95-7 (Aug. 1, 1958).

The accidental cancellation of terms which is used to explain the non-allowed shape of the β-spectrum is shown to lead to values of the longitudinal polarization less than 0.8 v/c. This is consistent with the observed anomalously small value. M.A.Grace

539.165

623. MEASUREMENT OF THE LONGITUDINAL POLARIZATION OF ELECTRONS EMITTED IN β-DECAY OF Tm^{170}, Lu^{177}, Au^{198}, Sm^{153}, Re^{186}, Sr^{90} AND Y^{90}. II.
A.I.Alikhanov, G.P.Eliseev and V.A.Lyubimov.
Zh. eksper. teor. Fiz., Vol. 34, No. 5, 1045-57 (1958). In Russian.
See also: Nuclear Phys., Vol. 7, No. 6, 655-71 (Aug., 1958).

For Pt I see Abstr. 2552 (1958). Longitudinal polarization of electrons in Coulomb β-transitions is measured for various values of the electron energy. For all investigated substances the magnitude of the longitudinal polarization was found equal to $-v/c$. The most probable relations between the interaction constants in β-decays are $C_T = -C_T$, $C_S = -C'_S$, $C_V = C'_V$, $C_A = C'_A$.

539.165 : 530.145

TESTS FOR TIME REVERSAL INVARIANCE AND FEYNMAN-GELL-MANN THEORY IN ALLOWED BETA TRANSITIONS. See Abstr. 30

539.165.2

624. THE LONGITUDINAL POLARIZATION OF ELECTRONS IN ONCE FORBIDDEN β TRANSITIONS. A.Deloff.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 1, 57-9 (1958).

This is calculated for pure interactions, assuming a two-component neutrino. It is found to be close to ± v/c. The results agree with those of Curtis and Lewis (Abstr. 2548/1958). J.C.Taylor

539.165.2

625. THE COULOMB EFFECT IN β DECAY. A.Deloff.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 5, 327-33 (1958).

An exact solution of the Dirac equation in the Coulomb field of the nucleus is given as an alternative to the traditional spherical-wave solution. The alternative wave-function possesses the full utility of the plane wave solution, simplifying β-decay calculations and obviating the introduction of a very complicated density matrix. This method was used to calculate the spectra and longitudinal polarizations of electrons for the allowed and first forbidden transitions, and the results are identical with the results previously obtained by other workers. A.E.I. Research Laboratory

539.165.2

626. THE THEORY OF FORBIDDEN β-DECAY.
G.E.Lee-Whiting.
Canad. J. Phys., Vol. 36, No. 9, 1199-244 (Sept., 1958).

The angular distributions of electrons and of neutrinos and the polarization of the electrons emitted by an oriented source in β-decay of arbitrary forbiddenness are calculated in terms of various angular-momentum coupling constants and of certain generalizations of the well-known combinations of electron radial wave-functions, L_ν, M_ν, N_ν, ... The interaction Hamiltonian used encompasses all five invariants; neither parity conservation nor time-reversal invariance is assumed. A particularly simple procedure for calculating the longitudinal polarization of electrons emitted by an oriented source is pointed out. The polarization is equal to $\pm\nu/c$, to good approximation, if the two-component neutrino theory holds. Explicit results for various allowed and first-forbidden effects are quoted.

539.166

627. AN APPROXIMATE EXPRESSION FOR GAMMA-RAY DEGRADATION SPECTRA. U.Fano and A.T.Nelms.
J. Res. Nat. Bur. Stand., Vol. 59, No. 3, 207-10 (Sept., 1957).

The equation for gamma-ray degradation spectra is reduced to a form suitable for a simple approximation. The approximation is valid in a wavelength range between two Compton wavelengths larger than the wavelength of the source and the region where photoelectric absorption becomes very intense; this range is wide for low Z materials. Input data are provided for application to various materials and source energies. The results of sample calculations are shown and compared with those obtained by standard numerical calculation.

539.166

628. COHERENT SCATTERING OF 1.33 MeV γ-RAYS BY LEAD.
K.G.Standing and J.V.Jovanovich.
Nature (London), Vol. 182, 521-3 (Aug. 23, 1958).

Values of the differential scattering cross-section measured at angles up to 150^0 appear to be smaller than the theoretical predictions for nuclear Thomson and Rayleigh scattering.

M.A.Grace

539.166

629. ANGULAR CORRELATIONS OF GAMMA RAYS IN CASCADE FROM LEVELS IN Lu^{175} AND Hf^{177}. E.D.Klema.
Phys. Rev., Vol. 109, No. 5, 1652-5 (March 1, 1958).

The directional angular correlations of the 208.36–112.97 keV gamma–gamma cascade in Hf^{177} and the 89.36–343.40 and 282.57–113.81 keV cascades in Lu^{175} were measured with a coincidence scintillation spectrometer using NaI detectors. The observed correlation functions obtained with dilute aqueous solution sources are $W(\theta) = 1 - (0.1614 \pm 0.0015)P_2(\cos\theta)$, $W(\theta) = 1 + (0.001 \pm \pm 0.004)P_2(\cos\theta)$, and $W(\theta) = 1 + (0.221 \pm 0.004)P_2(\cos\theta)$, respectively. These results, taken together with conversion coefficient measurements, indicate that δ^2 for the 282.57 keV gamma-ray in Lu^{175} is 0.05. The sign of δ, defined below, is positive. The mixing ratio of the 208.36 keV gamma-ray in Hf^{177} is M2/E1 = 0.001; in this case the sign of δ is negative. The sign of δ for the 113.81 keV gamma-ray in Lu^{175} is positive, and the sign of δ for the 112.97 keV gamma-ray in Hf^{177} is negative.

539.166

630. GAMMA RAYS FROM Rb^{84m}. L.Cohen.
Phys. Rev., Vol. 111, No. 2, 587-9 (July 15, 1958).

NaI(Tl) scintillators were used to study the gamma radiations from the isomer Rb^{84m}. The radiations were observed to consist of three components having energies of 216 ± 3 keV, 250 ± 3 keV, and 464 ± 3 keV. The half-life of the radiations, the intensities of the gamma-rays, and the angular correlation between the 216 keV and the 250 keV radiations were measured. The measurements are consistent with the following assignments: the first excited state is located at 250 ± 3 keV and has J = 3+; the isometric state is located at 464 ± 3 keV and has J = 6+.

539.166

631. GAMMA RADIATION FROM THE DECAY OF ^{113}Sn.
R.K.Girgis and R.van Lieshout.
Physica, Vol. 24, No. 8, 672-82 (Aug., 1958).

The gamma-radiation accompanying the decay of 118 day Sn^{113} was studied with scintillation detectors, using kicksorters. The relative intensities of the 393 keV and the 257 keV gamma-rays were found to be 100 : (3.0 ± 0.3). Chemical separations show that the 257 keV radiation belongs to Sn^{113} and not to its 1.75 hr In^{113} daughter. There is some evidence for a weak transition of 605 ± 10 keV. Remarks about the decay scheme are added.

539.166

632. NUCLEAR SPECTROSCOPY OF NUCLIDES OF THE THORIUM FAMILY, WITH THE METHOD OF DISCRIMINATED COINCIDENCES. F.Demichelis and B.Chinaglia.
R.C. Accad. Naz. Lincei, Vol. 22, No. 5, 613-15 (May, 1957).
In Italian.

The γ-spectrum of the nuclides Th^{228}, Ra^{224}, Pb^{212}, Bi^{212} and Tl^{208} in the low energy region (0.05 – 0.75 MeV) was investigated. The coincidence between a given γ-ray, selected by means of a differential kicksorter and the other γ-rays of the spectrum selected by a second kicksorter, were recorded. The results obtained are listed briefly. G.Martelli

539.166 : 539.165

633. CIRCULAR POLARIZATION OF GAMMA RAYS FOLLOWING SOME FIRST-FORBIDDEN BETA TRANSITIONS. F.Boehm.
Z. Phys., Vol. 152, No. 3, 384-6 (1958).

Beta–gamma circular polarization measurements were made on As^{76}, Rb^{86}, and Au^{198} and the corresponding anisotropy coefficients found to be +0.03 ± 0.12, +0.08 ± 0.09 and +0.45 ± 0.06. These are interpreted on the basis of maximal interference between Fermi and Gamow–Teller decay modes. M.A.Grace

539.166.07

634. IMPROVED METHOD OF GAMMA-RAY CALORIMETRY.
I.T.Myers.
Rev. sci. Instrum., Vol. 29, No. 9, 758-61 (Sept., 1958).

A method of using an isothermal calorimeter is described in which experimental errors are minimized by the proper selection of the time of measurement. The method was applied to the calorimetric measurement of the activity of a 2-curie cobalt-60 source.

539.166.83 : 539.14

635. SPECTRA OF CONVERSION ELECTRONS FROM Gd^{151} AND Gd^{153}.
N.M.Anton'eva, A.A.Bashilov, B.S.Dzhelepov and B.K.Preobrazhenskiĭ.
Izv. Akad. Nauk. SSSR, Ser. fiz., Vol. 22, No. 2, 135-52 (1958).
In Russian.

By taking the spectra of the conversion electrons after one year, the authors were able to free the Sm^{153} and Gd^{153} decays to Eu^{153} from small half-life contamination. Agreement was found in this work on the Eu^{153} level scheme with the results obtained in Coulomb excitation. By finding unique multipolarities for the gamma-rays involved, the authors were able to assign spins and parities to the ground state and the five excited states up to 187 keV in Eu^{153} as $5/2^+$, $7/2^+$, $5/2^-$, $3/2^+$, $1/2^+$ and $9/2^+$ respectively. As Eu^{153} is permanently deformed, a comparison was made with the level scheme obtained from Nilsson's deformed-well calculations and satisfactory agreement was found. During the above internal-conversion measurements, lines were found corresponding to a half-life of 120 days and these were ascribed to Gd^{151} which decays to Eu^{151}. From their measurements, from Coulomb excitation results and from beta-decay rates, the authors propose a level scheme for the spherical nucleus, Eu^{151}. By assuming shell-model assignments for the ground states, tentative spin and parity assignments were assigned to all levels up to 440 keV in Eu^{151} as $d_{5/2}$, $g_{7/2}$, $s_{1/2}$, $h_{11/2}$, $d_{3/2}$, $9/2^-$, $9/2^+$ and $f_{7/2}$. Electron–electron coincidences gave more information on the various cascades involved and the decay scheme proposed was verified reasonably well by finding the conversion of most of the transitions proposed. W.O.Lock

539.166.83

636. CONVERSION SPECTRA OF SOME NEUTRON-DEFICIENT ISOTOPES OF Tb.
N.M.Anton'eva, A.A.Bashilov, B.S.Dzhelepov and B.K.Preobrazhenskiĭ.
Dokl. Akad. Nauk SSSR, Vol. 119, No. 2, 241-3 (1958). In Russian.

Extension of previous work on Gd to Tb (see preceding abstract). W.O.Lock

539.166.83

637. INTERNAL CONVERSION ANGULAR CORRELATIONS. E.V.Ivash.
Nuovo Cimento, Vol. 9, No. 1, 136-44 (July 1, 1958).

The angular correlation function is evaluated analytically for the correlation between a γ-ray and an internal conversion electron. A relativistic treatment is presented for the following cases: (1) the 2^{L+1} magnetic pole–2^{L} electric pole mixture for s, $p_{1/2}$, and $p_{3/2}$ electrons, and (2) the 2^{L+1} electric pole–2^{L} magnetic pole mixture for $p_{1/2}$ and $p_{3/2}$ electrons.

539.166.83

638. INVESTIGATION OF THE DECAY OF POLONIUM-210. B.P.Singh, H.S.Hans and P.S.Gill.
Nuovo Cimento, Vol. 9, No. 4, 699-705 (Aug. 16, 1958).

The conversion coefficient of 800 keV γ-rays from the decay of Po^{210} was measured, using a scintillation method, to be 0.039 ± 0.01. The value of the conversion coefficient was also obtained by the measurement of conversion electrons with an end-window type G.M. counter. The absorption curve for electrons is given and its shape is interpreted in the light of the results of Lagasse and Doyeb. The value of the conversion coefficient obtained in this way is 0.014 ± 0.005. The discrepancy between the two values is explained as due to K and L shell ionization by α-particles. No coincidences were found between the different parts of the γ-ray spectrum.

539.166.83

639. ELECTRIC-MONOPOLE DIRECTIONAL-CORRELATION EXPERIMENTS. E.L.Church, M.E.Rose and J.Weneser.
Phys. Rev., Vol. 109, No. 4, 1299-306 (Feb. 15, 1958).

Angular-correlation experiments involving conversion electrons are sensitive to a small admixture of electric-monopole (E0) transitions. The coefficient of $P_2(\cos\theta)$ in the correlation function involving a mixed E0 + M1 + E2 transition contains an interference term between the E0 and E2 electrons, which is proportional to the ratio of the E0 and E2 matrix elements. Measurement of this coefficient provides a sensitive means for determining both the magnitude of the monopole matrix element and its phase relative to the E2 gamma-ray matrix element. The effect on the directional-correlation function between such K-conversion electrons and a coincident gamma ray is calculated explicitly. Specific numerical results are given for Pt (Z = 78) over a range of energies, and the feasibility of the method is illustrated with reference to the particular case of the $2+ \rightarrow 2+ \rightarrow 0+$ cascade in Pt^{196}.

539.166.83

640. L_I, L_{II}, L_{III}, AND M INTERNAL CONVERSION LINES OF THE 411.8 keV TRANSITION IN Hg^{198}. D.Reitmann, H.Schneider and I.J.van Heerden.
Phys. Rev., Vol. 110, No. 5, 1093-4 (June 1, 1958).

The L_I:L_{II}:L_{III}:M internal conversion ratios were measured and compared with the theoretical E2 values. The results indicate that the finite nuclear size effect, if present, is small.

539.166.83 : 539.165

641. EVIDENCE FOR THE PRESENCE OF E0 IN DIRECT COMPETITION WITH M1 AND E2. T.R.Gerholm and B.G.Pettersson.
Phys. Rev., Vol. 110, No. 5, 1119-22 (June 1, 1958).

Gamma–electron and electron–gamma angular directional correlation measurements were obtained for the 334.0 – 356.5 keV cascade in Pt^{196} by use of a beta-spectrometer and a NaI:Tl scintillation detector. The result obtained for the $\bar{A}_2$ term in the gamma–electron case is in agreement with earlier gamma–gamma measurements by Steffen. The electron–gamma $\bar{A}_2$ term gives evidence for admixtures due to electric monopole internal conversion as predicted by Church and Weneser (Abstr. 8318/1956).

539.166.83

642. POLARIZATION OF CONVERSION ELECTRONS FOLLOWING β DECAY. M.E.Rose and R.L.Becker.
Phys. Rev. Letters, Vol. 1, No. 3, 116-18 (Aug. 1, 1958).

It is pointed out that the conversion electrons following β-decay will be transversely polarized and that an angular correlation measurement will give information on the β-decay interaction. Expressions for the correlation function are given. M.A.Grace

539.166.83

643. THE SPECTRUM OF M- AND L-AUGER ELECTRONS FROM Bi^{212} AND Tl^{208}. K.Risch.
Z. Phys., Vol. 150, No. 1, 87-98 (1958). In German.

This was measured in the range 1-15 keV, using a magnetic lens spectrometer; energies and assignments are given for 21 L-Auger lines. A.O.Stanesby

NUCLEAR REACTIONS

539.17 : 535.376 : 539.1.07

ENERGY–RANGE RELATION IN VARIOUS MATERIALS FOR LIGHT AND HEAVY FISSION FRAGMENTS. See Abstr. 490

539.17

NUCLEAR REACTIONS DUE TO COSMIC RAYS. See also the Section entitled "COSMIC RAYS".

539.17 : 539.14

644. POLARIZATION OF PROTONS PRODUCED IN THE $C^{12}(p,p)C^{12}$ REACTION [AT INCIDENT ENERGIES OF 1.625-1.840 MeV]. P.S.de Toledo and S.Watanabe.
An. Acad. Brasil. Cienc., Vol. 27, No. 4, 471-7 (1955). In Portuguese.

539.17

645. DIRECT INTERACTION IN THE REACTION $^{16}O(p,\alpha p)^{12}C$. D.Chlebowska.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 9, 883-6 (1957).

The discovery of a correlation between the emitted alpha-particles and scattered nucleons in (n,α) or (p,α) reactions might indicate a direct knock-out of the alpha-particle from the nucleus by the incident nucleon. The reaction $O^{16}(p,\alpha p)C^{12}$ is treated theoretically by an impulse approximation method for an incident proton energy of 18 MeV assuming that the proton interacts with only one alpha-particle, O^{16} being chosen since its properties are aptly described by the alpha-particle model. Theoretical curves are presented for (1) the angular distribution of alpha-particles with a fixed angle of 180° between their direction of emission and that of the emitted proton, (2) the energy distribution of the same alpha-particles at angles of 0°, 20° and 40° to the beam direction. A theoretical angular distribution for the $O^{16}(p,\alpha)N^{13}$ reaction is also presented. A.E.I.Research Laboratory

539.17

646. MASS SPECTROMETRIC STUDIES OF THE INTERACTION OF GOLD WITH 3.0 BeV PROTONS. B.M.Gordon and L.Friedman.
Phys. Rev., Vol. 108, No. 4, 1053-7 (Nov. 15, 1957).

Gold targets were irradiated with 3.0 BeV protons and the yields of caesium, barium, and rubidium nuclides investigated by mass spectrometry. A high-sensitivity surface-ionization technique, using a multiple filament source arrangement and capable of determining (within 5%) 10^8 alkali metal atoms, was developed. The separation of products from the gold target was accomplished by extracting the gold into diethyl ether. The contamination level of stable Cs^{133} in the gold foil and reagents was determined by isotope dilution methods to be $\sim 9 \times 10^9$ atoms. Ratios of production cross-sections for neutron-deficient caesium isotopes and their barium parents were calculated from mass spectra. Cross-sections were placed on an absolute scale by a radiochemical determination of the Cs^{127} cross-section. No caesium isotopes with $A > 128$ are formed in appreciable independent yield. An upper limit of 0.002 millibarns was placed on cross-sections for Cs^{132} and the neutron-excess caesium isotopes. No stable caesium resulting from nuclear reactions was detected above the natural contamination background. Ratios of production cross-sections for rubidium radioisotopes were determined. The natural contamination of rubidium was too large to place a meaningful limit on stable rubidium production.

539.17 : 539.14

647. COMPOUND STATES FORMED IN THE REACTION $Ca^{40}(p, p'e^+e^-)$. R.D.Bent and T.H.Kruse.
Phys. Rev., Vol. 109, No. 4, 1240-2 (Feb. 15, 1958).

The absolute yield of electric monopole pairs from the $Ca^{40}(p, p'e^+e^-)$ reaction was measured as a function of bombarding energy from $E_p = 4.1$ to 6.0 MeV. The pairs, resulting from the decay of the 0^+ first excited state of Ca^{40} at 3.35 MeV to the 0^+ ground state, were detected with a scintillation pair spectrometer. Weak resonances were observed at 4.42, 4.74, and 4.90 MeV bombarding energy. Resonances about 20 times stronger were observed at $E_p = 5.02$ and 5.08 MeV and higher energies. Seventeen resonances were observed between 5.0 and 6.0 MeV bombarding energy. The reduced widths and spacings of levels in the compound nucleus Sc^{41} at 5.9 to 6.6 MeV excitation energy are derived from these data.

539.17 : 539.14

648. PROTON STRENGTH FUNCTIONS FROM (p,n) CROSS SECTIONS. C.H.Johnson, A.Galonsky and J.P.Ulrich.
Phys. Rev., Vol. 109, No. 4, 1243-54 (Feb. 15, 1958).

To an accuracy of ±10%, (p,n) total cross-sections averaged

over resonances were measured from threshold to about 500 keV above threshold for 12 nuclei from Cl^{37} to Nb^{93}. For each nucleus the excitation function of the average cross-section is a monotonically increasing function of proton energy. At 500 keV above threshold the cross-sections vary from 40 millibarns for Cl^{37} to 5×10^{-4} millibarns for Nb^{93}. One new threshold, that for $Se^{77}(p,n)Br^{77}$, was found to be 2.175 ± 0.004 MeV. In the course of calibrating the neutron detector with an Sb–Be source, a new determination was made of the Sb^{124} half-life: 59.9 ± 0.5 days. A black-nucleus square-well model was used to compute the cross-sections for formation of the compound system. The Coulomb penetrabilities that appear in this calculation qualitatively account for the very large range of cross-sections observed. In a more detailed comparison compound-nucleus formation was assumed, and the Hauser–Feshbach formalism (Abstr. 7577/1952) was used to include the effects of proton and, especially, γ-ray emission from the compound nucleus. In general, there is agreement with the shapes of the excitation functions but not always with the magnitudes. The ratio of observed to black-nucleus cross-section peaks up by about a factor of 2 between Cu^{65} and Se^{82}. The maximum in the peak is between masses 70 and 75. This peak may be correlated (by a complex-potential model) with a peak in the strength function for s-wave protons and, to a lesser extent, with a peak in the strength function for d-wave protons. Proton strength functions were calculated for a complex square-well of radius $R = 1.45\ A^{1/3} \times 10^{-13}$ cm with the approximation of a Coulomb potential constant inside the well and equal to $(4/3)(Ze^2/R)$. In order to fit the observed position of the peak, A ~ 70 to 75, the depth of the specifically nuclear part of the well was required to be 46 MeV, 4 MeV deeper than the neutron well of Feshbach, Porter, and Weisskopf (Abstr. 524/1955).

539.17 : 539.14

649. SCATTERING OF 12 MeV PROTONS, 24 MeV DEUTERONS, AND 48 MeV ALPHA-PARTICLES BY BERYLLIUM.
R.G.Summers-Gill.
Phys. Rev., Vol. 109, No. 5, 1591-603 (March 1, 1958).

A beryllium target was bombarded with 12 MeV protons, 24 MeV deuterons, and 48 MeV alpha-particles. With the three projectiles, the differential cross-sections for inelastic scattering leading to the formation of the 2.43 MeV state were measured. Application of inelastic-scattering theory leads to the assignment for this level, spin $\frac{5}{2}$ and odd parity. A very weak inelastic proton group was found which could correspond to a level in Be^9 at ~ 1.8 MeV. The observation of inelastic alpha-particle groups corresponding to levels at 6.8 and 11.3 MeV makes definite the assignment of isotopic spin $\frac{1}{2}$ to these states. The data obtained are not inconsistent with the existence of levels at 3.1 and 4.8 MeV. The pickup reaction $Be^9(p,d)Be^8$ (ground state) was observed. Although the distribution is peaked forward as predicted by Butler, the shape is the same as that found at other energies. Such behaviour is not consistent with the quantitative aspects of the theory. The reactions $Be^9(p,np')Be^8$ and $Be^9(\alpha,n\alpha')Be^8$ were studied. Analysis of the angular distributions suggests that those processes in which the charged particle retains most of the energy occur predominantly by direct interaction. Finally, the elastic scattering of protons, deuterons, and alpha-particles was observed. Analysis of these distributions assuming a black nucleus gives reasonable agreement with the positions of the diffraction effects. The radii of interaction that are necessary are large but consistent within themselves and with those that fit the inelastic data.

539.17

650. ENERGY DEPENDENCE OF F^{19} + p REACTIONS.
W.A.Ranken, T.W.Bonner and J.H.McCrary.
Phys. Rev., Vol. 109, No. 5, 1646-51 (March 1, 1958).

Excitation functions were obtained for the $F^{19}(p,\alpha\pi)O^{16}$, $F^{19}(p,\alpha_0)O^{16}$, $F^{19}(p,\alpha\gamma)O^{16}$, and $F^{19}(p,p'\gamma)F^{19}$ reactions for proton energies of 1.2 to 5.4 MeV. The marked similarity of the pair and long-range alpha excitation functions is noted and in the proton energy interval 1.35 to 2.33 MeV the differences between the yields are explained by the penetration factors for alpha-particles emitted from the excited states of Ne^{20}. The average reaction cross-section was obtained for the F^{19} + p reactions by averaging the excitation functions over one-half MeV intervals. The result is compared to the cross-section given by the continuum theory.

539.17 : 539.14

651. INVESTIGATION OF FOUR RESONANCES IN THE REACTION $Si^{29}(p,\gamma)P^{30}$. C.van der Leun and P.M.Endt.
Phys. Rev., Vol. 110, No. 1, 96-104 (April 1, 1958).

Thin Si^{29} targets were bombarded with protons from a Cockcroft–Walton generator in the energy region E_p = 0.2 to 0.8 MeV. The gamma-radiation from the $Si^{29}(p,\gamma)P^{30}$ reaction was investigated with a NaI scintillation spectrometer at the 326, 414, 693, and 729 keV resonances. Pulse spectra taken at each resonance at angles of $\theta = 0$ and $\theta = 90$ degrees to the proton beam were analysed with a 70-channel Hutchinson–Scarrott kicksorter. The decay of the resonance levels was further investigated by γ–γ coincidence measurements. The following spins, J, parities, and isobaric spins, T, could be assigned to P^{30} levels: Ground state, $J = 1^+$, $T = 0$; 0.684 MeV $J = 0^+$, $T = 1$; 0.706 MeV, $J = 1^+$, $T = 0$; 1.45 MeV, $J = (2^+)$, $T = 0$; 2.94 MeV, $J = 2^+$, $T = 1$; 4.18 MeV, $J = 2^+$, $T = 1$; 5.88 MeV, $J = 2^-$, $T = 1$; 5.96 MeV, $J = 1^-$, $T = 0$; 6.23 MeV, $J = 1^-$, $T = 1$; 6.27 MeV, $J = 3^-$, $T = 0$. The reaction Q-value is measured as Q = 5.570 ± 0.030 MeV. From absolute gamma-ray yield measurements, the radiation widths of all resonance levels could be determined. These levels are shown to have T as a good quantum number. The strong gamma-rays are of E1 character and satisfy the isobaric-spin selection rule for self-conjugate nuclei.

539.17

652. COULOMB EXCITATION OF MEDIUM-WEIGHT EVEN–EVEN NUCLEI. P.H.Stelson and F.K.McGowan.
Phys. Rev., Vol. 110, No. 2, 489-506 (April 15, 1958).

The yields of gamma-rays resulting from Coulomb excitation were measured for twenty-nine even–even medium weight nuclei ($92 \leq A \leq 130$). The projectiles used for effecting Coulomb excitation were variable-energy protons (1.5 to 3.3 MeV) and doubly-ionized helium ions (8 to 10 MeV). In the most favourable cases the absolute γ-ray yields are determined to an accuracy of ±40%. The reduced electric quadrupole transition probabilities, B(E2), are determined to an accuracy of ±7% in favourable cases. For the least favourable case the accuracy is ±20%. The observed values for B(E2) are larger than the single particle estimate by factors ranging from 6 to 64. The transition rates in the even–even tin isotopes are larger than the single particle estimate by a factor of 13. A strong correlation is found between the B(E2) and the inverse of the γ-ray energy for transitions with moderately large values for B(E2). The transitions are interpreted in terms of the collective vibrational model. The mass parameters obtained show remarkably little variation and are approximately ten times the irrotational flow estimate.

539.17 : 539.14

653. COULOMB EXCITATION STUDIES USING INELASTICALLY SCATTERED PARTICLES. R.D.Sharp and W.W.Buechner.
Phys. Rev., Vol. 109, No. 5, 1698-703 (March 1, 1958).

Targets of samarium, terbium, and cadmium were bombarded with protons, and in one case with deuterons, of up to 7.0 MeV and the inelastically scattered particles were observed. In the rare earths, samarium and terbium, four previously known levels were studied: the 58 and 139 keV levels in Tb^{159}, the 80 keV level in Sm^{154}, and the 123 keV level in Sm^{152}. The excitation process was determined to be primarily Coulomb excitation up to 7.0 MeV, and the reduced transition probabilities were measured with a precision of approximately 10%. A test of the collective model was made by measurement of the ratios of the reduced transition probabilities to two excited states in the same nucleus, Tb^{159}. Eight levels were observed in cadmium. Two of them, at 585 and 641 keV, have not been previously reported. The absolute cross-sections of the eight levels were determined with various angles of observation, incident energy, and type of bombarding particle. It was concluded that Coulomb excitation is a major contributor to the cross-section at 6.0 MeV, and reduced transition probabilities were measured at this energy.

539.17

654. MONTE CARLO CALCULATIONS ON INTRANUCLEAR CASCADES. I. LOW-ENERGY STUDIES.
N. Metropolis, R.Bivins, M.Storm, A.Turkevich, J.M.Miller and G.Friedlander.
Phys. Rev., Vol. 110, No. 1, 185-203 (April 1, 1958).

Nuclear cascade calculations of the Goldberger type were performed using the MANIAC electronic computer. A three-dimensional relativistic treatment was used. The target nuclei were Al^{27}, Cu^{64}, Ru^{100}, Ce^{140}, Bi^{209}, and U^{238}. Incident protons and neutrons with energies between 82 and 365 MeV were studied, but meson production was neglected in this energy range. Cascades initiated by about 1000 incident particles were followed in each case. The results were compared with those of previous calculations of this type, as well as with experimental photographic-plate data and counter measurements reflecting the cascade stage of high-energy nuclear reactions. The agreement with experimental data is usually good. Tables and graphs are presented showing the frequency of

occurrence of various residual nuclei, and data on the residual nuclear excitation energy after the cascade is over. A few comparisons with radiochemical data indicate overall agreement with the general spallation pattern of copper with 340 MeV protons and good agreement with the $Ni^{64}(p,n)Cu^{64}$ reaction over the energy range 100–400 MeV. However, the calculated results for the $Cu^{65}(p,pn)Cu^{64}$ reaction are low by almost a factor of two, although the energy dependence is approximately correct.

539.17

655. MONTE CARLO CALCULATIONS ON INTRANUCLEAR CASCADES. II. HIGH-ENERGY STUDIES AND PION PROCESSES. N.Metropolis, R.Bivins, M.Storm, J.M.Miller, G.Friedlander and A.Turkevich.
Phys. Rev., Vol. 110, No. 1, 204-19 (April 1, 1958).

The nuclear cascade calculations described in the preceding paper were extended to incident energies up to 1.8 BeV with the inclusion of pion production, scattering, and absorption processes. Again the MANIAC electronic computer was used. Several incident proton energies between 450 MeV and 1.8 BeV were investigated, with Al^{27}, Cu^{64}, Ru^{100}, Ce^{140}, Bi^{209}, and U^{238} as target nuclei. Cascades initiated by pions of several energies up to 1500 MeV incident on Ru^{100} were also studied. The elementary cross-sections used and the assumptions made about details of the inelastic nucleon–nucleon and pion–nucleon processes are presented. The results of the calculation are summarized in tables and graphs giving data on transparencies, on numbers, energy spectra, and angular distributions of emitted cascade nucleons and pions, and on frequencies of occurrence and excitation energies of residual nuclei. The computed number distributions, energy spectra, and angular distributions of emitted particles are compared with the results of several emulsion experiments with incident protons and negative pions. The agreement is generally satisfactory, but certain discrepancies are found, for example regarding spectra and angular distributions of emitted pions; some of these discrepancies are discussed in terms of details of the model used. The calculation predicts quite well the overall yield distribution of spallation products of copper produced by 2 BeV protons; however, as at lower energies, the calculated cross-sections for (p,pn) reactions are too low by factors of two or three.

539.17

656. AN IMPULSE APPROXIMATION FOR THE DEUTERON STRIPPING REACTION. G.Rakavy.
Nuclear Phys., Vol. 7, No. 6, 553-60 (Aug., 1958).

The deuteron stripping at low and intermediate energies is treated in a way resembling somewhat the impulse approximation. The neutron–proton interaction is considered twice: first it determines the initial conditions of the problem and then this same interaction is considered as a perturbation inducing transitions between various eigenstates determined by the strong interaction of the target nucleus with the impinging particles. The nuclear parameters entering the calculation are, besides the reduced widths, the scattering amplitudes of free neutrons and protons. In the present treatment room is made for some resonance phenomena. Also the effect of the Coulomb forces can be treated in a rather straightforward manner.

539.17 : 539.14

657. MAGNETIC ANALYSIS OF THE REACTION $V^{51}(d,p)V^{52}$. F.A.El Bedewi and S.Tadros.
Nuclear Phys., Vol. 8, No. 1, 71-8 (Sept. [1], 1958).

The protons emitted from the bombardment of a thin vanadium target by 8.67 MeV deuterons were analysed with a magnetic spectrograph and detected by nuclear photographic emulsions. Seven new excited levels in V^{52} were observed at 3.74, 4.27, 4.46, 4.72, 4.92, 5.23 and 5.48 MeV with errors varying between ±0.02 and ±0.03 MeV. The angular distributions of some proton groups corresponding to a number of low lying levels are measured and compared with theoretical curves based on stripping mechanism. For the ground level in V^{52}, the neutron is captured in the $2p_{3/2}$ state. This suggests that in the shell model the $1f_{5/2}$ state lies above the $2p_{3/2}$ state. A spin of 3^+ is proposed for this ground level.

539.17 : 539.12

658. POLARIZATION OF PROTONS FROM $B^{10}(d,p)B^{11}$, $C^{12}(d,p)C^{13}$, AND SPIN-FLIP STRIPPING. J.C.Hensel and W.C.Parkinson.
Phys. Rev., Vol. 110, No. 1, 128-35 (April 1, 1958).

The polarization of proton groups corresponding to the ground and first excited states in the reactions $B^{10}(d,p)B^{11}$ and $C^{12}(d,p)C^{13}$ was measured for an incident deuteron energy of 7.8 MeV. With the exception of the first excited state of B^{11}, the sign of the polarization for six known cases is consistent with the relation $P = (\pm)$ when $j_n = l_n \mp \frac{1}{2}$, the axis of quantization being defined by $n = k_p \times k_d$. The anomalous polarization of the first excited state of B^{11} is interpreted as evidence for a spin-flip exchange process in the stripping reaction.

539.17 : 539.14

659. GROUND-STATE DOUBLET OF P^{32}. W.C.Parkinson.
Phys. Rev., Vol. 110, No. 2, 485-8 (April 15, 1958).

Angular distribution obtained for each member of the ground-state doublet of P^{32} in the reaction $P^{31}(d,p)P^{32}$ indicate that for both levels the neutron is captured with $l_n = 2$, and that the s-wave admixture for the ground state is about 5%. Estimates of the purity of the P^{31} ground-state wave function are made on the basis of the available experimental data.

539.17

660. ANALYSIS OF C^{12} + d REACTIONS. M.T.McEllistrem.
Phys. Rev., Vol. 111, No. 2, 596-607 (July 15, 1958).

The $C^{12}(d,d)C^{12}$ scattering is analysed at two levels in N^{14}, one at 12.42 MeV excitation and the other at 12.60 MeV. The lower level is assigned as 4^- and the upper as 3^+. A nuclear radius is assumed and reduced widths are obtained for the two levels. With the aid of the reactions $C^{12}(d,p)C^{13}$ and $C^{12}(d,p)C^{13*}$ (3.09 MeV level), partial level widths for the three modes of decay of N^{14*} are obtained. Both (d,p) reactions are shown to be consistent with the presence of stripping amplitudes and resonant compound nuclear amplitudes and also consistent with the $B^{10} + \alpha$ data of Shire et al. for the same excitation region in N^{14}. The (d,p) angular distributions are analysed to obtain the reduced neutron widths of the ground and first excited states of C^{13}. An appendix gives an explicit partial-wave expansion of the differential cross-section for reactions involving incident spins of 0 and 1 and outgoing spins of $\frac{1}{2}$ and $\frac{1}{2}$.

539.17

661. THE YIELD OF THE NUCLEAR REACTION $Al^{27}(d,2p)Mg^{27}$. R.Radicella, J.Rodriguez, G.B.Baró and E.O.Hittmair.
Z. Phys., Vol. 150, No. 5, 653-6 (1958). In German.

The cross-section of the reaction was measured for $10 \leq E_d \leq 28$ MeV; the experimental values favour the process of total deuteron absorption followed by evaporation of the protons.

A.O.Stanesby

539.17

662. PHENOMENOLOGICAL RELATION BETWEEN ELECTRON AND PHOTON DISINTEGRATION OF NUCLEI. B.Bosco and S.Fubini.
Nuovo Cimento, Vol. 9, No. 2, 350-2 (July 16, 1958).

The relation of the electron disintegration total cross-section to the total photon disintegration cross-section has previously been calculated in electric dipole approximation (Abstr. 6430/1949). A similar relation is established in electric dipole approximation, between the photon and electron differential cross-sections for any two-body disintegration of nuclei. It is suggested that an experimental check of this relation, could give the limits of validity of the electric dipole approximation. A.E.I. Research Laboratory

539.17

663. STUDY OF THE $Ge^{70}(\gamma,n)Ge^{69}$ AND $Ge^{76}(\gamma,n)Ge^{75}$ REACTIONS. O.A.Borello, J.Goldemberg and M.D.S.Santos.
An. Acad. Brasil. Cienc., Vol. 27, No. 4, 413-15 (1955).
In Portuguese.

539.17

664. STUDY OF THE $K^{39}(\gamma,n)K^{38}$ AND $Cl^{38}(\gamma,n)Cl^{34}$ REACTIONS. O.A.Borello, J.Goldemberg and M.D.S.Santos.
An. Acad. Brasil. Cienc., Vol. 27, No. 4, 417-25 (1955). In Portuguese.

539.17

665. STUDIES ON THE NUCLEAR PHOTOEFFECT. M.D.de Souza Santos, J.Goldemberg, R.R.Pieroni, E.Silva, O.A.Borello, S.S.Villaça and J.Leite Lopes.
An. Acad. Brasil. Cienc., Vol. 27, No. 4, 437-70 (1955).

Photonuclear reactions induced in several elements by the X-ray beam from a 24 MeV betatron were accurately measured by means of the residual activity technique. Thresholds and cross-sections for different photonuclear processes were measured with a fairly high accuracy and are discussed in this paper. Some influence of shell structure on the photoprocesses was observed.

539.17

666. THE PHOTODISINTEGRATION OF POTASSIUM BY $^7Li(p,\gamma)$ RADIATION. T.R.Ophel.
Proc. Phys. Soc., Vol. 72, Pt 3, 321-5 (Sept., 1958).

The proton spectrum of the reaction $K^{39}(\gamma,p)$ was obtained at 17.6 MeV. Transitions to known levels in A^{38} at 2.16 and 3.75 MeV

were identified and proton groups of energies as low as 2 MeV were resolved, corresponding to levels in A^{38} at 4.3, 5.0, 5.4, 6.3, 6.6, 7.3 and 7.85 MeV. The total (γ,p) cross-section for the reaction at 17.6 MeV is found to be in excess of 11 millibarns.

539.17

667. RESONANCE ENERGY OF THE NUCLEAR GIANT RESONANCE. M. Fabre de la Ripelle.
C.R. Acad. Sci. (Paris), Vol. 247, No. 13, 926-9 (Sept. 29, 1958). In French.

Constructs a quantum-mechanical version of the Goldhaber–Teller explanation of this giant resonance. Neutron and proton co-ordinates relative to their separate centres of mass are introduced, and the nuclear wave-function is assumed to factorize into states of internal motion (relative coordinates) and of collective motion (centres of mass). The first excited "collective" level gives the giant resonance; estimates of the energy agree with experiment.

R.J.N.Phillips

539.17

668. (γ,n) AND (γ,2n) REACTIONS IN ^{93}Nb.
E.Silva, J.Goldemberg, P.B.Smith and L.Marquez.
Nuovo Cimento, Vol. 9, No. 1, 17-22 (July 1, 1958).

The (γ,n) cross-section of Nb^{93} was measured by the residual activity method. Combining this result with the total neutron yield curve it was possible to separate the contributions of the (γ,n) and (γ,2n) reactions. The ratio of these cross-sections was then compared with special attention to the 2.35 isomeric state (half-life 13 hr) reported by James; this activity was not found and an upper limit was determined as 0.02% of the 0.93 MeV line. An activity of 3.2% abundance due probably to γ-rays from annihilation of positrons was found.

539.17

669. ENERGY SPECTRA OF PHOTONEUTRONS FROM Cr AND Ta. G.Cortini, C.Milone, A.Rubbino and F.Ferrero.
Nuovo Cimento, Vol. 9, No. 1, 85-98 (July 1, 1958).

The energy spectra of photoneutrons emitted at 90° by Cr and Ta under bremsstrahlung of 20 and 30 MeV were investigated by means of the recoil protons in photoemulsion. A scanning method was followed, which gives some advantage for the study of the high energy tail of the spectra. The yield variations are consistent with the second maximum in the cross-section by Ferrero et al. The interpretation of the second maximum on the ground of a quasi-deuteron absorption process seems to be excluded. A tentative explanation of experimental results is discussed.

539.17

670. ANGULAR DISTRIBUTION OF PHOTOPROTONS FROM SILICON. V.Emma, C.Milone and A.Rubbino.
Nuovo Cimento, Vol. 9, No. 2, 343-5 (July 16, 1958).

Natural silicon targets were irradiated by a 30 MeV bremsstrahlung beam and the emitted photoprotons detected by means of nuclear emulsion plates. The angular distribution of protons having energies greater than 7 MeV, greater than 5 MeV and less than 3.5 MeV were plotted separately. The two higher energy groups had an anisotropic distribution indicating E_1 dipole absorption with superimposed contribution of higher multipole terms. The angular distribution of lower energy protons was isotropic indicating compound nucleus formation. By comparing the proton yield with that from carbon an approximate integrated cross-section of 0.23 MeV barn was deduced for natural silicon. A.E.I. Research Laboratory

539.17

671. PHOTONEUTRONS FROM Au.
S.Cavallaro, V.Emma, C.Milone and A.Rubbino.
Nuovo Cimento, Vol. 9, No. 4, 736-9 (Aug. 16, 1958).

Photoneutrons from a 60 g gold target were detected at approximately 90° to the collimated 30 MeV bremsstrahlung beam from the B.B.C. Turin betatron, using Ilford C2 emulsions 200 microns thick and a total exposure of 2647 roentgens. The neutron spectrum so obtained is plotted for the energy range 1.5 to 18 MeV approximately. It shows a high energy tail predicted by evaporation theory. This may be explained by assuming that approximately 15% of the neutrons are emitted by a direct interaction process which leaves the residual nucleus in its ground state. The high energy tail for gold is less than that observed by the same authors for tantalum and chromium.

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539.17

672. YIELD AND ANGULAR DISTRIBUTION OF FAST PHOTONEUTRONS FROM DEUTERIUM AND CARBON.
P.S.Baranov, V.I.Gol'danskii and V.S.Roganov.
Phys. Rev., Vol. 109, No. 5, 1801-6 (March 1, 1958).

The yield and angular distribution of fast photoneutrons (with energies > 20.6 MeV) from carbon and deuterium nuclei was investigated using a 265 MeV synchrotron. The experimental results obtained at photon energies below as well as above the threshold for meson production are discussed from the viewpoint of the two-nucleon model.

539.17 : 539.14

673. INTRINSIC QUADRUPOLE MOMENT AND THE RESONANCE WIDTH OF PHOTONUCLEAR REACTIONS. K.Okamoto.
Phys. Rev., Vol. 110, No. 1, 143-53 (April 1, 1958).

The correlation between nuclear deformation and the resonance width of photonuclear reactions is discussed. The general trend of the nuclear deformation is in good agreement with the predictions of Marumori, Suekane, and Yamamoto (Abstr. 6428, 6430/1957), and the existence of the correlation is clarified. The calculation assuming the splitting of the resonance and a constant width for spherical nuclei agrees qualitatively with experiments, but quantitatively the calculated values are too low, especially for strongly deformed nuclei. For light nuclei the quantitative calculation has little meaning, but a similar correlation is found for them. The mass-number dependence of the resonance width is discussed qualitatively; it turns out that the variation of this width arises from various causes and is not a simple function of mass number. A discussion of the nuclear shape in the highly excited state (~ 20 MeV) is given, and it is shown that this nuclear shape may not be very different from the shape in the ground state.

539.17 : 539.14

674. PHOTONEUTRON THRESHOLDS FOR IRON, GERMANIUM, RUBIDIUM, AND HAFNIUM. R.Tobin, J.McElhinney and L.Cohen.
Phys. Rev., Vol. 110, No. 6, 1388-91 (June 15, 1958).

Photoneutron thresholds for Fe^{56}, Fe^{57}, Ge^{73}, Rb^{85}, Rb^{87}, Hf^{177}, and Hf^{179} were measured by using bremsstrahlung from a 22 MeV betatron as a photon source. The photon-induced reactions were observed by neutron detection supplemented in one case by radioactivity determinations. A comparison of these thresholds with neutron binding energies revealed that, for some of the nuclei, better agreement was obtained if formation of the residual nucleus in an excited state instead of in the ground state was assumed. The neutron binding energies inferred from these measurements are: 11.34 ± 0.10 MeV for Fe^{56}; 7.85 ± 0.13 MeV for Fe^{57}; 6.50 ± 0.16 MeV for Ge^{73}; 10.50 ± 0.08 MeV for Rb^{85}; 9.89 ± 0.05 MeV for Rb^{87}; 6.70 ± 0.09 MeV for Hf^{177}; and 6.52 ± 0.12 for Hf^{179}.

539.17

675. PHOTOPRODUCTION OF ALPHA PARTICLES FROM SEVERAL METALLIC ELEMENTS. M.E.Toms and J.McElhinney.
Phys. Rev., Vol. 111, No. 2, 561-7 (July 15, 1958).

Photoproduction of alpha-particles from copper was investigated by using 22 MeV bremsstrahlung to irradiate a "sandwich" consisting of a thin copper foil (2.75 mg/cm^2) placed between two Ilford E-1, 100 micron thick nuclear emulsions. The observed yield was $(3.9 \pm 0.6) \times 10^4$ alpha-particles per mole-roentgen. The energy distribution of the alpha particles has a maximum near 8 MeV. In addition, photoproduced alpha-particles from thin foils of eleven elements, including copper, were detected by means of their tracks in nuclear emulsions. "Sandwiches" containing two target foils on either side of a lead stopping foil were exposed to 21.5 MeV bremsstrahlung hardened by 147.4 g/cm^2 of graphite. The photo-alpha yields observed with the hardened spectrum are given in terms of unhardened bremsstrahlung, having been multiplied by the calculated ratio of effective photons in the two spectra. These yields in units of 10^4 alphas per mole-roentgen, are: Al—1.3, V—0.4, Fe—1.9, Co—2.3, Ni—3.9, Cu—2.6, Cu^{63}—3.6, Zn—8.2, Nb—0.5, Rh—0.3, Ag—0.17, and In—0.09. For the seven elements having $Z \leq 30$, there seems to be a correlation between yield and the difference between the alpha and neutron binding energies.

539.17 : 539.12

676. PHOTOPRODUCTION OF π^--MESONS FROM BORON.
I.S.Hughes and P.V.March.
Proc. Phys. Soc., Vol. 72, Pt 2, 259-62 (Aug., 1958).

The reaction $B^{11}(\gamma,\pi^-)C^{11}$ was studied using bremsstrahlung having peak energies from 70 MeV to 320 MeV, by measuring the activity of the C^{11} product of the reaction. The cross-section for the reaction is in agreement with theoretical values for surface production. An unexplained activity is detected below the energy threshold for meson production.

539.17

677. THE RESONANT ABSORPTION OF γ-RAYS IN ^{14}N.
G.M.Griffiths.
Proc. Phys. Soc., Vol. 72, Pt 3, 337-44 (Sept., 1958).

Using a nitrogen filled proportional counter the resonant absorption of γ-rays to the 8.06 MeV level in N^{14} was observed by means of the $N^{14}(\gamma,p)C^{13}$ reaction. The inverse reaction $C^{13}(p,\gamma)N^{14}$ at the 554 keV resonance was used as the source of γ-rays. The γ-ray flux was accurately measured with a scintillation counter and from the results the width of the 8.06 MeV level for ground state γ-ray transitions was found to be 10.5 ± 0.6 eV. This is in good agreement with the value obtained from the results of Seagrave (Abstr. 2982/1952) on the inverse reaction $C^{13}(p,\gamma)N^{14}$. Since the γ-ray energy is a function of angle due to a Doppler shift the resonant character of the absorption has been shown by varying the angle of the proportional counter with respect to the proton beam direction and noting the change in proton yield.

539.17

678. CONSERVATION OF PARITY IN A NUCLEAR INTERACTION AT 350 MeV. D.P.Jones, P.G.Murphy and P.L.O'Neill.
Proc. Phys. Soc., Vol. 72, Pt 3, 429-32 (Sept., 1958).

If parity is conserved, neutrons produced in the interaction of unpolarized protons with an unpolarized target should have zero longitudinal component of polarization. An experiment is described in which the longitudinal polarization of the 350 MeV neutron beam emerging from an internal beryllium target in a synchrocyclotron is measured. The result is that, if the reaction matrix describing the neutron production process contains a term $F(\vec{\sigma}.\vec{P}/P)$, where $\vec{\sigma}$, $\vec{P}$ are the neutron spin and momentum, then $|F|^2 \leq 3.6 \times 10^{-6}$ with 95% confidence.

539.17 : 539.12

MESON PHOTOPRODUCTION IN HYDROGEN AND DEUTERIUM.
See Abstr. 549

539.17

679. THE CROSS SECTION FOR THE REACTION $Cs^{135}(n,\gamma)Cs^{136}$. A.P.Baerg, F.Brown and M.Lounsbury.
Canad. J. Phys., Vol. 36, No. 7, 863-70 (July, 1958).

The effective cross-section for the reaction Cs^{135} (n,γ) Cs^{136} with reactor neutrons is 10.4 ± 0.5 barns. The measured reaction rate under cadmium yields a value of 61.7 ± 2.3 barns for the resonance integral of Cs^{135}. The thermal cross-section is 8.7 ± 0.5 barns as obtained by combining the reaction rates for uncovered and cadmium-covered samples.

539.17

680. THERMAL NEUTRON ABSORPTION CROSS SECTION OF XENON-124. J.M.Tobin and J.H.Sako.
J. appl. Phys., Vol. 29, No. 9, 1373 (Sept., 1958).

A mean value of 74.4 barns is calculated from activities of five neutron-activated Xe samples. No total error is given, but the neutron flux was known to ± 25%. A.E.I. Research Laboratory

539.17

681. ON THE MECHANISM OF THE (n,2n) REACTION AT 14 MeV NEUTRON ENERGY. E.Remy and K.Winter.
Nuovo Cimento, Vol. 9, No. 4, 664-78 (Aug. 16, 1958).

Neutron spectra emitted by Be^9, Mn^{55}, Fe, I^{127} and Ta^{181} under bombardment of 14 MeV neutrons were measured by using time-of-flight techniques. Continua of the first neutrons are separated from low energy groups due to the second neutrons. Successive emission is predominant for medium weight and heavy nuclei. A possible contribution of simultaneous emission by light nuclei cannot be decided. The conclusion is used to interpret inelastic scattering data from the interaction of 14 MeV neutrons.

539.17

682. A NEW DEVELOPMENT IN THE AREA METHOD OF NEUTRON RESONANCE ANALYSIS. J.E.Lynn.
Nuclear Phys., Vol. 7, No. 6, 599-612 (Aug., 1958).

The area method of neutron resonance analysis was extended to include the effect of various interference terms which may enter the formula for the neutron resonance cross-section. The principal interference term is that between resonance and potential scattering. A series formula was found for the area function which takes account of this term when Doppler broadening is negligible. Doppler broadening is treated by numerical computation. The practical application of these formulae is discussed. Interference caused by other resonances may be important. It can be represented by cross terms between resonances and is treated as a correction to the area function.

539.17 : 539.14

683. NEUTRON TOTAL CROSS SECTIONS IN THE keV REGION BY FAST TIME-OF-FLIGHT MEASUREMENTS.
W.M.Good, J.H.Neiler and J.H.Gibbons.
Phys. Rev., Vol. 109, No. 3, 926-33 (Feb. 1, 1958).

A new method employing millimicrosecond time measurement was used to study neutron total cross-sections in the 2 to 30 keV energy range. The method was applied to the nuclides Na^{23}, Al^{27}, P^{31}, K^{39}, K^{41}, Rb^{85}, Rb^{87}, Sr^{86}, Sr^{88}, Y^{89}, Bi^{209}, and to natural Ti, Se, and Pb. A general result is that with the improved resolution of the new instrument, some new levels have appeared and a few previously reported were not observed. Of some special interest is the 2.8 keV resonance in Na^{23} which was definitely shown to have J = 1, σ_0 = 380 ± 10 barns. It was observed that the strength function drops about a factor of ten when two protons are added to Rb^{87} to make Y^{89}.

539.17 : 539.12

684. LOW-ENERGY NEUTRON RESONANCES IN Sm^{149}.
H.Marshak and V.L.Sailor.
Phys. Rev., Vol. 109, No. 4, 1219-21 (Feb. 15, 1958).

The total neutron cross-section of Sm^{149} was measured in the energy range from 0.06 to ~ 20 eV using a crystal spectrometer with resolution 0.17 μsec/meter. The Breit–Wigner parameters were obtained for four of the larger resonances at energies of 0.0976 ± 0.0005, 0.870 ± 0.003, 4.93 ± 0.03, and 8.9 ± 0.1 eV. The radiation widths for these four resonances are, respectively, in units of 10^{-3} eV: 63.6 ± 1.0, 59.8 ± 1.0, 66.7 ± 3.0, and 66.6 ± 6.0. Other resonances were found at energies of 6.4 ± 0.1, 12.0 ± 0.5, 14.8 ± 0.5, and 17.0 ± 0.5 eV.

539.17 : 539.14

685. PROPERTIES OF s-WAVE AND p-WAVE NEUTRON RESONANCES IN NIOBIUM.
A.Saplakoglu, L.M.Bollinger and R.E.Coté.
Phys. Rev., Vol. 109, No. 4, 1258-62 (Feb. 15, 1958).

The neutron resonances of niobium were studied with the Argonne fast chopper. The transmission of a series of four samples was measured over the range of energy from 10 to 10 000 eV. Resonance parameters were deduced for thirteen levels, those below 700 eV. An examination of these parameters, calculations with the optical model, and a comparison of the cross-sections at low and high energy all indicate that some of the resonances, even those below 100 eV, are due to a p-wave process. By using this evidence, average parameters are deduced. The radiation width is found to be 0.22 eV. The strength function $\overline{\Gamma}_n^0/\overline{D}$ for s-wave neutrons is 0.10×10^{-4}. The value of the corresponding quantity for p-wave neutrons is 4.6×10^{-4}. The resonance absorption integral deduced from the parameters is found to be in agreement with the result of a "pile oscillator" measurement.

539.17 : 539.14

686. NEUTRON RESONANCES IN THE keV REGION: DIFFERENTIAL SCATTERING CROSS SECTIONS.
R.C.Block, W.Haeberli and H.W.Newson.
Phys. Rev., Vol. 109, No. 5, 1620-31 (March 1, 1958).

The ratio of the differential elastic neutron scattering cross-sections for scattering by 180° and 90°, $R = \sigma_{nn}(180^\circ)/\sigma_{nn}(90^\circ)$ was measured as a function of neutron energy between approximately 30 and 110 keV for F, Na, Mg, Al, K, V, Cr, Cu, Zn, As, Se, Sr, Zr, Nb, Mo, Ag, and Cd. When plotted against atomic weight, the average ratios R (averaged over the energy range of each element) exhibit peaks at A ≅ 90 and A ≅ 25, in qualitative agreement with the predictions of the complex square-well potential model of the nucleus. However, the experimental ratios are in general larger than those predicted by the theory. Scattering from the lighter elements was also analysed by single-level resonance theory and resulted in the following assignments: resonance in Al at 88 keV, $J = 3^+$; Mg (85 keV), $\frac{5}{2}^-$; Na (53 keV), 3^-; F (99 keV), 1^-; F (49 keV), 1^-; F (27 keV), 1^- or 2^-. These assignments are in good agreement with those obtained from the latest transmission measurements.

539.17

687. EMISSION OF SECONDARY NEUTRONS FROM NUCLEI BOMBARDED BY HIGH-ENERGY NEUTRONS.
V.I.Gol'danskiĭ, A.E.Ignatenko, A.I.Mukhin, V.S.Pen'kina and V.A.Shkoda-Ulyanov.
Phys. Rev., Vol. 109, No. 5, 1762-9 (March 1, 1958).

The mean number of secondary neutrons emitted in a single act of absorption of 120 and 380 MeV neutrons by Be, C, Al, Fe, Cu, Sn and Pb nuclei was determined for secondary neutron energies up to ~ 15-20 MeV; the neutrons are predominantly

emitted as a result of evaporation which occurs after an intranuclear nucleon cascade. The mean number of secondary neutrons was found to increase monotonically from carbon (ν = 1-1.8) to lead (ν = 6.6-9.9) and was almost constant when the primary neutron energy was varied from 120 to 380 MeV. The experimental results are compared with those obtained by studying star formation in nuclear emulsions and also fission of heavy nuclei and the production of neutrons by cosmic rays.

539.17 : 539.14

688. NEUTRON SCATTERING CROSS SECTION OF U^{235}. H.L.Foote, Jr.
Phys. Rev., Vol. 109, No. 5, 1641-4 (March 1, 1958).

The neutron elastic scattering cross-section for U^{235} was measured by the "thick–thin" method over the range of neutron energies from 0.27 to 7.7 eV. The cross-section rises at lower energies, the rise being qualitatively that expected if an unusually strong level were present just below the binding energy. Analysis of the data in terms of a Breit–Wigner single-level formula gives a resonant and a constant component. The solution yields a value of 10 ± 1 barns for the constant component, which may be identified as the "potential scattering" cross-section. This result is relatively insensitive to the location of the bound level and to the exact analytical form of the resonant component. The magnitude of the resonant component is not in perfect quantitative agreement with the parameters commonly quoted for the "negative energy" resonance at $E_0 = -1.4$ eV. This disagreement is probably not significant because of the uncertainties in the analysis of both the total and the scattering cross-section.

539.17

689. NEUTRON SCATTERING CROSS SECTION OF U^{233}. S.Oleksa.
Phys. Rev., Vol. 109, No. 5, 1645 (March 1, 1958).

The neutron scattering cross-section of U^{233} as a function of energy was measured by means of a crystal spectrometer in the energy range 0.27 to 0.95 eV and at 2.09, 2.71, and 3.31 eV. Least-squares analyses of these data indicate that at these energies the scattering cross-section is approximately constant, i.e., 12.5 ± 0.5 barns.

539.17

690. NEUTRON ACTIVATION CROSS SECTION OF TECHNETIUM 98. E.Anders.
Phys. Rev., Vol. 110, No. 2, 427-30 (April 15, 1958).

The cross-section for the reaction $Tc^{98}(n,\gamma)Tc^{99m}$ was determined by thermal neutron irradiation of a cyclotron-produced sample containing Tc^{96}, Tc^{97m}, Tc^{97g}, Tc^{98} and Tc^{99}. The degree of selectivity and background reduction required to permit an accurate measurement of the Tc^{98} content, 2.68 ± 0.54 disintegrations per minute, was attained by means of β-(740 keV γ) coincidence counting. At a thermal flux of 2.1 ± 10^{12} neutrons cm^{-2} sec^{-1}, a saturation activity of 375 ± 85 dis/min Tc^{99m} per dis/min of Tc^{98} was obtained. Using the latest value of the half-life of Tc^{98}, $(1.5 \pm 0.7) \times 10^6$ years, one finds a cross-section of 2.6 ± 1.3 barns. Relative cross-sections are also given for the production of several technetium isotopes by bombardment of molybdenum with 10.2 MeV deuterons.

539.17

691. INELASTIC SCATTERING OF 14 MeV NEUTRONS FROM CARBON AND BERYLLIUM. J.D.Anderson, C.C.Gardner, J.W.McClure, M.P.Nakada and C.Wong.
Phys. Rev., Vol. 111, No. 2, 572-4 (July 15, 1958).

The angular distributions of the neutrons from the reactions $Be^9(n,n')Be^{9*}$, Q = −2.43 MeV, and $C^{12}(n,n')C^{12*}$, Q = −4.43 MeV, were measured from 25° to 140°, employing 14 MeV incident neutrons. Neither distribution is symmetric about 90°; the inelastically scattered neutrons are peaked in the forward direction. The $C^{12}(n,n')$ first-level angular distribution, which agrees with a recent measurement of the $C^{12}(p,p')$ distribution, is in good agreement with the prediction of the Levinson–Banerjee direct interaction theory. The integrated inelastic scattering cross-sections for the Be^9 and C^{12} first levels are 0.17 ± 0.03 barn and 0.22 ± 0.03 barn, respectively. The 4.43 MeV de-excitation gamma-rays from C^{12*} are symmetric about 90°. The gamma-ray production cross-section at 90° is 13.1 ± 2.0 mb/sterad. No gamma-rays associated with Be^{9*} are seen. It is concluded that about one-third of the (n,2n) cross-section at 14 MeV is a two-stage process proceeding via the 2.43 MeV level in Be^9.

539.17

692. ABSOLUTE MEASUREMENT OF (n,2n) CROSS SECTIONS AT 14.1 MeV.
V.J.Ashby, H.C.Catron, L.L.Newkirk and C.J.Taylor.
Phys. Rev., Vol. 111, No. 2, 616-21 (July 15, 1958).

Absolute cross-sections were obtained by counting double-pulse events in a 240-gal cadmium-loaded liquid scintillator. The detection efficiency was determined experimentally using a spontaneous fission source and known values of $\bar{\nu}$. Conventional methods were used to measure the absolute neutron flux. Cross-sections were measured for C, N, F, V, Fe, Cu, Ag, Ta, Cd, Au, Pb, Bi, D, and Be. The values in barns are: C, 0.006 ± 0.006; N, 0.019 ± 0.010; F, 0.062 ± 0.009; V, 0.66 ± 0.05; Fe, 0.50 ± 0.04; Cu, 0.76 ± 0.06; Ag, 1.73 ± 0.13; Ta, 2.64 ± 0.20; Cd, 1.92 ± 0.14; Au, 2.60 ± 0.20; Pb, 2.74 ± 0.20; Bi, 2.60 ± 0.19; D, 0.20 ± 0.02; Be, 0.54 ± 0.04. The (n,2n) cross-sections for the last six elements are, within error, equal to the nonelastic cross-sections. Nuclear temperatures are calculated.

539.17

693. SCATTERING OF NEUTRONS ON NON-SPHERICAL NUCLEI. E.V.Inopin.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1455-64 (1958). In Russian.

A method for calculation of scattering of neutrons by semi-transparent nuclei based on use of the exact solutions of the wave equation in spheroidal coordinates is described.

539.17 : 539.14

OXYGEN DIFFERENTIAL NEUTRON SCATTERING. See Abstr. 562

539.17 : 539.12

ANGULAR DISTRIBUTION OF NEUTRONS SCATTERED BY THE 2.80 keV RESONANCE IN SODIUM. See Abstr. 530

539.17 : 539.12

694. CAPTURE OF NEGATIVE MUONS BY LIGHT NUCLEI. J.Leite Lopes.
Phys. Rev., Vol. 109, No. 2, 509-14 (Jan. 15, 1958).

The capture of negative muons by protons can be regarded as taking place as a result of a direct coupling or via the π-meson field. An attempt is made to check whether the static, cutoff pseudovector coupling model of the π-meson–nucleon interaction can give rise to predictions on the capture of muons by nuclei in agreement with experiment. Chew theory leads to a capture rate 20 times smaller than that predicted by the direct-coupling theory. Accurate calculations can be made for the case of hydrogen, deuterium or helium, for which experimental information would be highly desirable. Comparison with the observational data for carbon, oxygen, and silicon, based on the ideal-gas model for nuclei, indicates that they are consistent with the direct-coupling theory. Meson theory gives a capture rate about 20 times too small.

539.17

695. INTERACTIONS OF 38 AND 61 MeV POSITIVE PIONS IN DEUTERIUM. A.M.Sachs, H.Winick and B.A.Wooten.
Phys. Rev., Vol. 109, No. 5, 1733-49 (March 1, 1958).

Measurements were made of the reactions (1) $\pi^+ + d \rightarrow \pi^+ + d$, (2) $\pi^+ + d \rightarrow \pi^+ + n + p$, and (3) $\pi^+ + d \rightarrow p + p$ at incident pion laboratory energies of 38 and 61 MeV using a liquid-deuterium target and scintillation counters. A separation of the three processes is obtained by determining the mass and energy of reaction products using a pulse-height analysis technique on the signals from the scintillation counters. Results from process (3) are compared with other processes involving two nucleons and a meson and results from processes (1) and (2) are compared with impulse approximation calculations.

539.17 : 539.12

696. MEASUREMENT OF THE SPIN-FLIP PROBABILITY IN PHOTOPRODUCTION OF NEGATIVE PIONS FROM DEUTERIUM. K.C.Bandtel, W.J.Frank and R.Madey.
Phys. Rev., Vol. 109, No. 6, 2117-21 (March 15, 1958).

Negative pions photoproduced from deuterium (i.e. from the neutron) by the synchrotron bremsstrahlung were investigated by observing pion–proton coincidences. A $(CD_2)n - (CH_2)n$ subtraction yields the neutron contribution. The purpose of the investigation is to determine how often the initial triplet spin state of the deuteron changes to a singlet spin state for the two final identical nucleons in the reaction $\gamma + d \rightarrow \pi^- + p + p$. LeLevier has calculated the pion-energy spectra under two assumptions: (a) the spin state always remains the same, and (b) the spin state always changes. The experimental measurements are integrals over meson energy from a lower limit upwards, and over the time of flight between the proton and the pion, within the resolution time of the coincidence system.

Thus, when the theoretically predicted spectra are folded into the experimental resolution of the equipment and the bremsstrahlung spectrum, there results a number proportional to the experimental measurement. The ratios of various experimental measurements can be compared with the theoretically predicted ratios. Within the limitations of the theory and the accuracy of the experimental measurements, the results indicate an interaction that is intermediate between the spin state's always changing and the spin state's never changing.

539.17

697. INTERACTION OF 1.5 BeV NEGATIVE π MESONS WITH EMULSION NUCLEI. J.E.Crew and R.D.Hill.
Phys. Rev., Vol. 110, No. 1, 177-84 (April 1, 1958).

The energy spectrum of charged pion secondaries, produced from emulsion nuclei by bombardment with 1.5 BeV negative pions, was measured. The spectrum was observed to be sharply peaked for pions of laboratory energies from 100 to 150 MeV. The mean pion energy was 148 MeV, and 75% of the pions were in the energy range from 50 to 150 MeV. The observed number of charged pions per star was 0.66. Half of the emulsion stars had no meson track, 36% had a single meson, 12% two mesons, and 2% more than two mesons. The experimental results were compared with Monte Carlo nuclear cascade calculations.

539.17 : 539.165

698. RECOIL EFFECTS IN K CAPTURE AND β DECAY. S.B.Treiman.
Phys. Rev., Vol. 110, No. 2, 448-50 (April 15, 1958).

A variety of effects is discussed involving polarization and directional asymmetries of the recoils produced in K capture and β decay. The effects in question, though they would be difficult to detect, may well be intrinsically large. They measure, essentially, the sign of the neutrino helicity. In particular, for the K-capture $\mu^- + C^{12} \rightarrow B^{12} + \nu$, one has the possibility to test for parity non-conservation and to determine the neutrino helicity in μ-meson capture.

539.17

699. FISSION OF URANIUM, SILVER, AND BROMINE NUCLEI WITH HIGH-ENERGY PARTICLES. G.F.Denisenko, N.S.Ivanova, N.R.Novikova, N.A.Perfilov, E.I.Prokoffieva and V.P.Shamov.
Phys. Rev., Vol. 109, No. 5, 1779-84 (March 1, 1958).

New data are presented on the high-energy fragmentation and fission of U, Ag, and Br in nuclear emulsions. The method of investigation is described. The nature of triple-pronged events involving fission of U with 560-660 MeV protons is disccused. Data are given concerning fission of U by 300 MeV π^+-mesons. The cross-section for the fission of Ag by high-energy protons is determined.

539.17

700. ANGULAR DISTRIBUTION OF FRAGMENTS FROM FISSION ON U^{238} AND Th^{232} BY 45, 80, AND 155 MeV PROTONS. J.W.Meadows.
Phys. Rev., Vol. 110, No. 5, 1109-13 (June 1, 1958).

Measurements were made of the angular distributions of $Sr^{91,92}$, $Ag^{112,113}$, Ba^{139} and the total fission products from proton-induced fission of U^{238} at 45, 80, and 155 MeV and Th^{232} at 45 and 155 MeV. The anisotropy decreases with increasing energy and is negative for asymmetric fission at 155 MeV.

539.17

701. PROMPT-NEUTRON EMISSION FROM SPONTANEOUS-FISSION MODES OF Cf^{252}. W.E.Stein and S.L.Whetstone,Jr.
Phys. Rev., Vol. 110, No. 2, 476-84 (April 15, 1958).

The number of prompt neutrons emitted and the velocities of the fragment pairs were measured for individual spontaneous fissions of Cf^{252}. The time-of-flight measurements of the fragment velocities have sufficient resolution to provide a good determination of the mode of fission as characterized by the total kinetic energy E_K and the mass ratio R_A of the fragments. The neutrons are detected with high efficiency in a large cadmium-loaded liquid scintillator. It is found that the dependence of the average number of neutrons per fission, ν, on the parameters E_K and R_A may be approximated by a plane $\nu(E_K,R_A)$ over the region that includes the majority of the fission events. The slopes that specify the orientation of this plane are determined to be $\partial\nu(E_K,R_A)/\partial E_K = -0.143 \pm \pm 0.020$ (neutrons/fission)/MeV and $\partial\nu(E_K,R_A)/\partial R_A = -6.3 \pm 1.1$ (neutrons/fission)/unit mass ratio. The value of the first slope indicates that the average total excitation energy of the fragments, required for the emission of one more neutron on the average, is 7.0 ± 1.0 MeV. From this number and the measured dependence of ν on mass ratio, the average excitation energy E_X of the fragments is determined as a function of the mass ratio. This function $E_X(R_A)$ and the measured dependence $E_K(R_A)$ determine the average prompt energy of fission as a function of mass ratio. The widths of the neutron-number distributions were obtained as functions of E_K and R_A. The data do not support the statistical theory of fission proposed by Fong.

539.17

702. ON THE THEORY OF THE QUASI-STATIONARY THERMONUCLEAR PROCESS. L.Biermann and A.Schlüter.
Z. Naturforsch., Vol. 12a, No. 10, 805-14 (1957). In German.

The conditions under which controlled thermonuclear processes can be used in a reactor are established. The discussion deals with the theoretical foundations and its applications to achieve and to maintain the necessary physical conditions.

539.17

703. FISSION ASYMMETRY. D.R.Inglis.
Ann. Phys. (New York), Vol. 5, No. 2, 106-40 (Oct., 1958).

A simplified treatment of the droplet model is presented. To bring the common fissionable nuclei to the region of the "saddle" in the energy surface, it is necessary to have deformations very far from the spherical shape. To study this region without expanding about a spherical shape, and to clarify some aspects of the process that might otherwise be hidden in large machine calculations, a simplified model of a nucleus near the saddle shape is introduced consisting of a cylinder with hemispherical ends. Relatively simple methods are used for estimating the change in electrostatic self-energy for small changes from this shape, and this is compared with the change of surface energy. A long charged cylinder of this sort does not expand indefinitely in length, and for the empirical values of the constants it always tends to contract. Above a certain minimum length, a neck may develop leading towards fission. The initial instability of the neck is considered under various conditions leading toward either symmetric or asymmetric fission. It is made clear that the neck has a strong tendency to start at the symmetric position, but if started asymmetrically it has a tendency to grow faster because of smaller reduced mass of the system. The droplet model alone does not provide an adequate explanation of the asymmetry of low-energy fission. The origin is discussed of fission asymmetry as related to other phenomena, particularly the observed angular anisotropies of fission and the low odd states of even nuclei. It is considered likely that specific nucleon effects may make the nucleus "pear-shaped" in the region of the saddle and beyond. Such effects may be related to, but not nearly as extreme as, the picture of two clusters, one with 50 and the other with 82 neutrons, and perhaps better calculated in terms of a small asymmetric deviation from spheroidal shape. It seems theoretically likely that such a mechanism is effective in some states and not others, and various experimental results on fragment mass distribution and angular anisotropy are interpreted most simply if the ground state and its rotational neighbours have saddles favouring asymmetry but some important excited states do not.

539.17

704. AIMS AND PROBLEMS OF REACTORS. E.P.Wigner.
Acta. phys. Austriaca, Vol. 11, No. 4, 410-21 (1958). In Germany.

A survey is made of the reasons why new energy sources will be required. The difficulties that occur in reactor design, such as neutron absorption in "breeder" reactors, are described, and the economics of reactors as sources of power examined. D.H.Lord

539.17

705. RESEARCH REACTORS. G.Ortner.
Acta. phys. Austriaca, Vol. 11, No. 4, 422-33 (1958). In German.

The neutron flux, the dependence of reactivity on temperature, the mean life of fission neutrons, etc., are discussed for the various types of reactor now used for research. These include natural uranium and homogeneous reactors, with various moderators. Several experiments on reactor safety are described. D.H.Lord

539.17 : 621.311.25

706. POWER REACTORS. S.Eklund.
Acta. phys. Austriaca, Vol. 11, No. 4, 434-51 (1958). In German.

The physical and technical details of power reactors constructed, or to be constructed, by Great Britain, U.S.A., U.S.S.R., Canada, France, EURATOM and O.E.E.C. are surveyed. Also two Swedish reactors, the R3 and ADAM, which are under construction and due to be completed in 1960, are described. D.H.Lord

539.17

707. SIMULATION OF HOT CHANNEL BOILING IN WATER-COOLED REACTORS. S.O.Johnson, N.J.Curlee and J.V.Reihing.
I.R.E. Trans Nuclear Sci., Vol. NS-5, No. 1, 1-9 (June, 1958).

The problems encountered in a study of the transient response

of a heat transfer system, in which the coolant experiences a phase change, are discussed. The differential equations which govern the system are presented. The analogue computer circuit is developed from the equations, and the peculiarities of the circuit are described. Analogue results of a typical coolant flow transient are presented.

539.17

708. THERMAL POWER CONTROL OF THE N.R.U. REACTOR. C.G.Lennox and A.Pearson.
I.R.E. Trans Nuclear Sci., Vol. NS-5, No. 2, 68-72 (Aug., 1958).

When reactor power is controlled only by neutron leakage flux, a difficulty arises because the factor relating neutron flux level to reactor power is a function of the flux distribution in the reactor. Due to variation in control rod positions, the flux distribution will vary. A method is presented for handling the problem by measuring the reactor thermal power and using this to adjust the power level demand circuits. A stability analysis is also given.

539.17

709. "TWO AND A HALF GROUP" EQUATIONS AND THEIR APPLICATION TO URANIUM—WATER SYSTEMS. J.Arkuszewski.
Nukleonika, Vol. 3, No. 2, 166-79 (1958). In Polish.

The most important physical properties of uranium—water reactors are reviewed and on this basis it is proposed to use four groups of neutrons in calculations. From the simple age-diffusion theory four-group equations are obtained by the method of Galanin, which are then reduced to a two group form (the "two and a half group" equations). Boundary conditions are given for these equations.

539.17 : 517.94

710. HOW TO SOLVE THE REACTOR EQUATION IN ELEVEN COORDINATE SYSTEMS. N.G.Sjöstrand.
Nukleonik, Vol. 1, No. 3, 89-93 (Aug., 1958).

The differential equation for the neutron flux in a bare reactor is $\nabla^2\Phi + B^2\Phi = 0$, according to the one-group theory. The eleven coordinate systems in which it is possible to solve this equation by separation of the variables are listed. For each system the coordinate surfaces, the form of the reactor equation, and the resulting ordinary differential equations are given. The fundamental solutions to these equations are included when they can be expressed in standard functions, and also the geometric buckling for some cases.

539.17

711. THE CRITICAL SIZE OF A HOMOGENEOUS REACTOR ACCORDING TO THE FOUR-GROUP DIFFUSION THEORY. D.Emendörfer, K.H.Höcker and M.Ritzi.
Z. Naturforsch., Vol. 11a, No. 9, 731-5 (1956). In German.

The diffusion of neutrons in the reactor is treated by dividing the entire energy range into four intervals. The diffusion equations are set out and the characteristic equation for the determination of the reactor size is discussed.

539.17

712. ON THE LINEAR KINETICS OF HOMOGENEOUS REACTORS. W.Humbach.
Z. angew. Phys., Vol. 9, No. 7, 333-5 (July, 1957). In German.

These are considered under the assumption of "complete turbulence". A.O.Stanesby

539.17

713. THE EFFECT OF THE REFLECTOR ON HETEROGENEOUS REACTORS. F.E.Prieto C.
Rev. Mexicana Fis., Vol. 7, No. 2, 55-64 (1958). In Spanish.

A method is presented for the calculation of the effect of the reflector on heterogeneous cylindrical finite reactors. Combining the results of this method with Medina's theory of heterogeneous reactors (Rev. Mexicana Fis., Vol. 3, No. 2, 1954), one obtains results,in agreement with experiment,for the masses of the materials in some known reactors. L.Pincherle

ATOMS

539.18

714. REVISED ENERGY LEVELS FOR THE NEUTRAL NITROGEN ATOM. K.B.S.Eriksson.
Ark. Fys., Vol. 13, Paper 34, 429-39 (1958).

By using a pulsed electrodeless discharge as a light source, wavelengths were determined by means of large concave-grating spectrographs for 110 lines of N I in the photographic infrared and 8 lines in the visible. In the vacuum ultraviolet accurate wavelengths for 16 lines between 1745 A and 1134 A were obtained from some old plates. From these data, which include about 50 newly-classified N I lines, the new terms $3d'^4P$, $3p'^2F$, $5p^2D$, $3s''^2S$, and $3d'^2G$ have been established. Improved values are derived for all levels involved in the present observations. Smoothed wavelengths in the vacuum ultraviolet are recalculated from the term system.

539.18

715. SEARCH FOR METASTABLE STATES OF THE DOUBLY EXCITED NEGATIVE HYDROGEN ION. H.Holøien.
J. chem. Phys., Vol. 29, No. 3, 676-7 (Sept., 1958).

Theoretical. The method of Abstr. 1993 (1958) is applied to ^3P states, and preliminary 10-parameter results indicate that there may be a metastable $(2p)^2$ state and a closed $(3p)^2$ state.

J.Hawgood

539.18

716. OPTICAL METHODS OF RADIOFREQUENCY RESONANCE. A.Kastler.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1148-67 (1957). In French.

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

539.18

717. SOME CONSEQUENCES OF THE COMPOUND ION MODEL. E.Baranger and E.Gerjuoy.
Proc. Phys. Soc., Vol. 72, Pt 3, 326-36 (Sept., 1958).

Cross-sections for excitation of atomic levels by electrons often vary sharply with energy near threshold, as if resonating with a state of the compound ion. Some consequences of this "compound ion model" of excitation are explored. In particular, it is shown that information bearing on the validity of the model can be obtained from measurements of the angular distribution and polarization of the light emitted following excitation to radiating states. Possible applications to mercury and to helium are discussed.

539.18 : 530.145

APPROXIMATE CALCULATION OF EIGENVALUES WITH SPECIAL REFERENCE TO THE HELIUM ATOM. See Abstr. 58

539.18 : 539.14

NUCLEAR RADII FROM MESONIC ATOMS. See Abstr. 572

539.18

718. SEPARATION OF BORON ISOTOPES. I. BORON TRIHALIDE ADDITION COMPOUNDS. R.M.Healy and A.A.Palko.
J. chem. Phys., Vol. 28, No. 2, 211-13 (Feb., 1958).

Isotopic separation factors for several gas—liquid systems for concentrating boron isotopes were determined. Separation factors at 25°C are:

System	(B^{10}/B^{11}) liq/(B^{10}/B^{11}) gas
BF_3(g) v. anisole · BF_3 (liq.)	1.032 ± 0.011 (95% C.I.)
BF_3(g) v. di-n-butyl sulphide · BF_3(liq.)	1.033 ± 0.005 (95% C.I.)
BF_3(g) v. phenol · BF_3 (liq.)	1.027 ± 0.014 (95% C.I.)

Separation factors for a number of BCl_3-organic systems were also studied, and a new compound $(C_6H_5)_2O \cdot BCl_3$ was prepared and characterized.

539.18

719. SEPARATION OF BORON ISOTOPES. II. THE BF_3 ANISOLE SYSTEM. A.A.Palko, R.M.Healy and L.Landau.
J. chem. Phys., Vol. 28, No. 2, 214-17 (Feb., 1958).

A new gas—liquid countercurrent system has been developed for the separation of boron isotopes. This system utilizes the exchange reaction between BF_3 gas and the BF_3 · methyl phenyl ether (anisole) complex. Quantitative dissociation of the complex is attained by heating, and recombination by cooling. Half-time for the isotopic exchange has been shown to be less than three seconds. The single-stage separation factor

$[B^{10}F_3 \cdot \text{anisole (liq.)}/B^{11}F_3 \cdot \text{anisole (liq.)}/B^{10}F_3\text{ (gas)}/B^{11}F_3\text{ (gas)}]$

varies from 1.039 at 0°C to 1.028 at 30°C. Physical properties of the complex were determined and solvent decomposition studied.

539.18 : 539.14

THEORY OF ISOTOPE SHIFT. See Abstr. 575

539.18 : 533.59

720. CONDENSATION COEFFICIENTS OF SILVER, GOLD, AND COPPER IN VACUUM DEPOSITION. S.Chandra and G.D.Scott.
Canad. J. Phys., Vol. 36, No. 9, 1148-53 (Sept., 1958).

A beam of atoms striking a substrate will in general not condense completely, but some of the incident atoms will re-evaporate. The condensation coefficient—defined as the ratio of the number of

atoms condensing to the total number incident on the substrate—was determined for silver at substrate temperatures from −30°C to 170°C, and for gold and copper at temperatures from 25°C to 165°C. For silver at room temperature the condensation coefficient is found to be 0.936, which indicates 6.4% of the incident atoms are re-evaporated or diffusely reflected. By a simple graphical analysis of the results it is shown that the temperature below which complete condensation occurs is 200°K for silver, 230°K for gold, and 180°K for copper.

539.18

721. ELECTRON LOSS CROSS SECTIONS FOR HELIUM ATOMS IN THE KINETIC ENERGY RANGE 100-450 keV. S.K.Allison.
Phys. Rev., Vol. 110, No. 3, 670-2 (May 1, 1958).

It is suggested that previous discrepancies between observers have been partially due to the fact that the neutral beams used contained varying amounts of metastable $1s2s\ ^3S_1$ atoms, depending on the pressure of the gas in which the He^0 beam was formed by electron capture from He^+. It is established that the new measurements were made on helium atomic beams whose loss cross-sections were independent of the pressure at which they were prepared over a ten-fold variation. The new values show the same trend with kinetic energy and the same relative values in H_2, He, and air as those previously reported in the 100-450 keV range, but their absolute values are lower. The new values agree with those obtained in other laboratories in the range 100-200 keV. The results are shown in the following table, in units of 10^{-7} cm² per atom of gas traversed:

Kinetic energy (keV)	$(\sigma_{01} + \sigma_{02})$ H_2	He	Air
100	4.2	7.5	16.4
150	5.8	8.9	21.2
250	5.7	9.7	23.2
350	6.0	8.4	22.0
450	7.0	8.2	24.5

539.18

722. ALIGNMENT OF METASTABLE HELIUM ATOMS BY UNPOLARIZED RESONANCE RADIATION. P.A.Franken and F.D.Colegrove.
Phys. Rev. Letters, Vol. 1, No. 9, 316-18 (Nov. 1, 1958).

Experimental and theoretical outline of a process by which the populations of the $^3S_1$ states with $m = \pm 1$ are increased at the expense of the $m = 0$ $^3S_1$ state because of preferential absorption of resonance radiation from the ^3P levels. The technique is somewhat similar to that of Abstr. 6469-70 (1957), known as "optical pumping".

J.Hawgood

539.18 : 533.59

CLEANUP OF ATOMIC HYDROGEN. See Abstr. 115

MOLECULES

539.19

723. DYNAMICAL STABILITY CRITERIA FOR MOLECULAR MOTIONS. A.D.Liehr and H.L.Frisch.
J. chem. Phys., Vol. 28, No. 6, 1116-20 (June, 1958).

The Poincaré classification theory of the singularities of the equations of motion of a classical mechanical system are suitably modified to describe the singularities in the motion of an arbitrary quantum mechanical system, derivable from a time-independent Hamiltonian. Dynamical quantum mechanical stability criteria are derived starting with the appropriate equations of motion satisfied by the Heisenberg position and momentum matrices of the system. These stability criteria are used to discuss and classify certain singular nuclear motions of molecular systems which are of some interest in the context of prevalent theories of chemical stability and chemical reaction kinetics. In particular it is shown that the singular nuclear motions of a molecular system whose electronic and nuclear motions can be assumed to be separable, reduce to the rolling motion of dynamically equivalent classical spheres on the electronic potential energy surface.

539.19 : 535.343

724. MICROWAVE SPECTRUM, INTERNAL BARRIER, STRUCTURE, EQUILIBRIUM CONFIGURATION, AND DIPOLE MOMENT OF METHYL MONOFLUOROSILANE. L.Pierce.
J. chem. Phys., Vol. 29, No. 2, 383-8 (Aug., 1958).

The microwave spectrum of methyl monofluorosilane was investigated in the region 18 to 38 kMc/s. Several transitions of the isotopic species CH_3SiH_2F and CH_3SiD_2F are split into doublets because of coupling of internal and over-all rotation. These splittings give a barrier to internal rotation of 1559 ± 30 cal/mole. The form of the potential barrier was assumed to be $V = \frac{1}{2}V_3(1 - \cos 3\alpha)$. A few transitions belonging to the first excited torsional state were observed and assigned. The splittings in the excited state are consistent with the barrier as determined from ground state observations. Rotational constants of CH_3SiH_2F, CH_3SiD_2F, $C^{13}H_3SiH_2F$, CD_3SiH_2F and CH_3SiDHF are determined and are used to calculate the structure of the molecule. The structural parameters are:

SiC	1.848 A	CSiF	109° 13'
SiF	1.600	HCH	107° 52'
SiH	1.473	CSiH	109° 28' (assumed)
CH	1.090	HSiH	109° 28' (assumed).

A study of CH_2DSiH_2F proves conclusively that methyl monofluorosilane in its equilibrium configuration has the methyl group staggered with respect to the SiH_2F group. The dipole moment was found to be 1.71 D.

539.19

725. DEPENDENCE OF FORCE CONSTANT ON ELECTRONEGATIVITY, BOND STRENGTH, AND BOND ORDER. VII. G.R.Somayajulu.
J. chem. Phys., Vol. 28, No. 5, 814-21 (May, 1958).

For previous work, see Abstr. 5572 (1957). The expression: $k_{AB} = (k_{AA}.k_{BB})^{\frac{1}{2}} + \Delta$ where k'S are the force constants of the bonds AA, AB, and BB of given type and Δ, an ionic contribution term, is suggested. For single bonds, the value for $\sqrt{\Delta}$ corresponds to the difference in the electronegativities of the atoms A and B in their valence states. In the case of multiple bonds the value for $\sqrt{\Delta}$ leads to proper value for the percentage ionic character of the bond. The force constant is shown to be proportional to the product of the strengths of the bond orbitals, the magnitude of a bond orbital in its angular dependence being defined as the strength with value 1 for an s orbital and 1.732 for a p orbital. The value for the sp^3 orbital is found to be about 2 but for sp^2 and sp orbitals, values differing from those suggested by Pauling are obtained. Among s—p bonds, digonal bonds are shown to be the strongest followed by trigonal and tetrahedral bonds. In alkali metals, the bonds are shown to be s—p bonds with strength 1.732. The force constant is shown to be linearly related to bond order. Finally, values for the force constants of various covalent bonds are assigned.

539.19

726. ON COVALENT BOND LENGTH AND BOND ORDER. VIII. G.R.Somayajulu.
J. chem. Phys., Vol. 28, No. 5, 822-4 (May, 1958).

Relationships between lengths of CC bonds and of bonds between other atoms are shown and a method of estimation of fractional bond order from bond length is presented.

539.19 : 537.564

727. DETERMINATION OF THE BINDING ENERGY OF He_2^+ FROM ION SCATTERING DATA. E.A.Mason and J.T.Vanderslice.
J. chem. Phys., Vol. 29, No. 2, 361-5 (Aug., 1958).

Data on the elastic and the charge exchange scattering of beams of He^+ ions in He gas between 4 and 400 eV are analysed to determine precisely the interaction energies for the lowest $^2\Sigma_u$ and $^2\Sigma_g$ states of He_2^+. A Morse function is used to represent the energy for the attractive $^2\Sigma_u$ state and an exponential is chosen for the repulsive $^2\Sigma_g$ state. An attempt is made to determine the three disposable parameters strictly from the scattering data, but does not lead to a unique result. However, use of the spectroscopic value of the equilibrium distance for the $^2\Sigma_u$ state permits a unique determination, leading to interaction energies valid from about 0.9 A to 3.8 A. The energies are in good agreement with available quantum-mechanical calculations and give a dissociation energy of 2.16 eV for the $^2\Sigma_u$ state. The cross-section calculations are given in reduced units in a form readily applicable to the calculation of binding energies for similar systems as data may become available.

539.19

728. A FURTHER CALCULATION OF THE GROUND STATE OF THE HYDROGEN MOLECULE. B.Kockel.
Z. Naturforsch., Vol. 11a, No. 9, 736-51 (1956). In German.

The ground state is calculated by the variational method for a five-constant energy function. The binding energy is determined as a function of the nuclear separation R for the range $1 \leq R \leq 2$ Bohr radii. The strongest binding occurs for R = 1.42 as 0.157 double Rydbergs = 4.26$_5$ eV.

539.19 : 535.343

729. ROTATIONAL SPECTRA OF RbF BY THE ELECTRIC RESONANCE METHOD.
H.Lew, D. Morris, F.E.Geiger, Jr and J.T.Eisinger.
Canad. J. Phys., Vol. 36, No. 2, 171-83 (Feb., 1958).

Transitions between the J = 0 and J = 1 rotational states of RbF were measured by means of the molecular beam electric resonance method. The following rotational constants were determined: $Y_{01} \cong B_e$; $-Y_{11} \cong \alpha_e$; $Y_{21} \cong \gamma_e$; B_e. The quadrupole interaction constants $-eqQ/h$ in the J = 1 state were also found. The equilibrium internuclear distance is $r_e = (2.26554 \pm 0.00005) \times 10^{-8}$ cm. The electric dipole moment of $Rb^{85}F$ in the v = 0 state is $\mu = (8.80 \pm 0.10) \times \times 10^{-18}$ e.s.u. The mass ratio of the Rb isotopes is $M_{85}/M_{87} = = 0.9770148 \pm 0.0000052$.

539.19

730. SUBSTITUTED METHANES. XXVIII. INFRARED SPECTRAL DATA AND ASSIGNMENTS FOR $CHCl_2F$ AND $CHClF_2$ AND POTENTIAL ENERGY CONSTANTS AND CALCULATED THERMODYNAMIC PROPERTIES FOR $CHCl_2F$, $CDCl_2F$, $CHClF_2$, AND $CDClF_2$.
H.B.Weissman, A.G.Meister and F.F.Cleveland.
J. chem, Phys., Vol. 29, No.1, 72-7 (July, 1958).

For Pt XXVII, see Abstr. 2484 (1957). Infrared spectral data were obtained with NaCl and CsBr prisms for gaseous $CHCl_2F$ and $CHClF_2$ from 270 to 4000 K (K = kayser = wave/cm) and the observed absorption bands were assigned to the vibrational modes for both molecules. Using the Wilson FG matrix method, reasonable values of the F-matrix elements were found which reproduced the observed wave-numbers to within 2%. These were then used to calculate the wave-numbers corresponding to the fundamental vibrations of $CDCl_2F$ and $CDClF_2$. Also, these F-matrix elements and analytical expressions obtained from the theory of Gold, Dowling, and Meister were used to get values of the f-matrix elements (potential energy constants). Having tested the assignments by the normal coordinate treatments, the observed wave-numbers for $CHCl_2F$ and $CHClF_2$ were then used to calculate the enthalpy function, the free energy function, the entropy, and the heat capacity for 1 atm pressure and for 12 temperatures from 100 to 1000°K, to a rigid rotor, harmonic oscillator, ideal gas approximation. Since the calculated wave-numbers for $CDCl_2F$ and $CDClF_2$ should be reliable to within about 2%, these were used in similar thermodynamic calculations to establish tentative values of the thermodynamic functions for these molecules.

539.19

731. INTERACTION OF THE VIBRATIONAL AND ELECTRONIC MOTIONS IN SOME SIMPLE CONJUGATED HYDROCARBONS. II. ALGEBRAIC EVALUATION OF THE INTEGRALS. A.D.Liehr.
Z. Naturforsch., Vol. 13a, No. 6, 429-38 (June, 1958).

An account of the evaluation of a number of integrals, not previously published which were involved in a calculation of intensities of vibronically allowed transitions in the spectrum of benzene.

R.C.Seymour

539.19 : 535.34

732. STUDIES UPON TRANSITION PROBABILITIES AND MOLECULAR EXCITATION. R.W.Nicholls.
Ann. Geophys., Vol. 14, No. 2, 208-24 (1958).

The basic concepts and parameters used to describe the radiation from atoms and molecules are outlined. The influences of Franck–Condon factors and electronic transition moments upon intensity distributions of molecular band systems are discussed in detail. Recent intensity measurements upon a number of important band systems are reviewed, and the variation of the electronic transition moment with internuclear separations discussed for a number of them.

539.19

733. ON THE COMPUTATION OF CERTAIN MULTICENTERED MOLECULAR INTEGRALS. J.W.Richardson.
J. chem. Phys., Vol. 28, No. 2, 362-3 (Feb., 1958).

Very encouraging results are obtained by using a Taylor series expansion instead of a Barnett–Coulson expansion of orbitals about points on which they are not centred. Tests on two-centre exchange integrals, carrying the expansion to second order only, gave errors less than 1%.

J.Hawgood

539.19

734. LIGAND FIELD THEORY OF Ni(II) COMPLEXES. I. ELECTRONIC ENERGIES AND SINGLET GROUND-STATE CONDITIONS OF Ni(II) COMPLEXES OF DIFFERENT SYMMETRIES. G.Maki.
J. chem. Phys., Vol. 28, No. 4, 651-62 (April, 1958).

A parametric method of calculating the electronic energies of an ion of configuration $3d^8$ ($3d^2$ positrons) when placed in a ligand field of point charges or dipoles is described. The method is applicable with a change of sign of the energy matrix elements to ions with a $3d^2$ electronic configuration. By use of the experimentally determined free ion term energies for the Ni(II) ion the calculations are made specific. The final energy eigenvalues obtained here are for the Ni(II) ion in four and six coordinated complexes of tetragonal, octahedral, cis-, and trans-planar symmetries. All free ion states of the same multiplicity and symmetry arising from the ground-state configuration were allowed to interact. An effective interelectron distance, dipole moment, and point charge were used as parameters. Some of the numerical results for specific values of the parameters are given as examples. The remainder of the energy calculations are tabulated. Minimum field strength conditions necessary for a four coordinated complex to become diamagnetic are determined using the calculated energies. The relative ease of conversion to a singlet ground state in the different symmetries is noted and the effect of an axial field on the change in multiplicity is obtained from the results of the calculations for the six-coordinated complexes.

539.19

735. LIGAND FIELD THEORY OF Ni(II) COMPLEXES. II. ELECTRONIC SPECTRA AND STRUCTURE OF SOME PARAMAGNETIC CHELATES. G.Maki.
J. chem. Phys., Vol. 29, No. 1, 162-72 (July, 1958).

An assignment of the observed absorption spectra is made for each of six paramagnetic Ni(II) chelates studied, based on the energy levels calculated for the Ni(II) ion from an electrostatic model of the complex. The best assignments in each case give resonably good qualitative and quantitative agreement, explaining the number and relative intensities of the triplet–triplet and triplet–singlet transitions and giving maximum error of 30% when compared with the observed positions of maximum intensity. The consistency and relative significance of the values of the effective dipole moments used for the different coordinating oxygen and nitrogen atoms is demonstrated in several specific assignments. For the chelates of unknown structure and coordination, a comparison of various possible assignments enables structural predictions, while the chelates of known structures are given reasonable assignments with their appropriate configurations. The sensitivity of the assignments to the assumed structures allowed the general conclusion to be drawn that significantly better results are obtained if unequal effective dipole moments of different ligands are used, rather than one average value. For example, all six coordinated chelates with mixed ligands were given better assignments in tetragonal or transplanar symmetry than octahedral symmetry. It is felt that this study demonstrates the scope of the electrostatic model of the complex ion and justifies its use to explain and predict properties of the complex molecule associated with the central ion.

539.19

736. ELECTRONIC STRUCTURE OF LiH. III. THE KNIPP WAVE FUNCTION. F.T.Ormand and F.A.Matsen.
J. chem. Phys., Vol. 29, No. 1, 100-2 (July, 1958).

For previous work see Abstr. 3421 (1958). The electronic energy and dipole moment of lithium hydride are computed from a 10-term wave-function which used orbitals of the James and Coolidge type (excluding terms containing interelectronic distances) for the valence electrons. The best energy obtained was -217.13^3 eV. The dipole moment is computed to be −5.574 D (hydrogen negative), significantly close to the −6.04 D obtained previously from a 6 structure valence-bond calculation based on Slater orbitals.

539.19

737. ELECTRONIC STRUCTURE OF BH_3.
W.L.Clinton and B.Rice.
J. chem. Phys., Vol. 29, No. 2, 445-6 (Aug., 1958).

Preliminary results of an SCF-LCAO treatment are given. It is suggested that a pyramidal biradical state with one elongated B–H bond might be the ground state, and this (even if it were a low excited state) would explain the structure of B_2H_6.

J.Hawgood

539.19

738. SPIN–ORBIT COUPLING IN THE $^3A_2$–$^1A_1$ TRANSITION OF FORMALDEHYDE. J.W.Sidman.
J. chem. Phys., Vol. 29, No. 3, 644-52 (Sept., 1958).

An approximate quantitative calculation is given for the effect of spin–orbit coupling in perturbing the $^3A_2$ state of H_2CO. The spin–orbit coupling mixes the $^3A_2$ state with some higher singlet state, and allows the $^3A_2 \leftarrow {}^1A_1$ transition to have nonvanishing probability. The calculations show that the $^3A_2 \leftarrow {}^1A_1$, $n_D \rightarrow \pi_2$ transition of H_2CO should be perturbed principally by the $^1A_1 \leftarrow {}^1A_1$, $\pi_1 \rightarrow \pi_2$ transition. The bands of the $^3A_2 \leftarrow {}^1A_1$ transition should therefore have the structure of a transition which is allowed by orbital symmetry with an oscillating electronic transition moment along the C–O axis (parallel bands). The oscillator strength, f, is calculated to be $f(^3A_2 \rightarrow {}^1A_1) \cong 1.5 \times 10^{-7}$. The natural radiative lifetime τ for the $^3A_2 \rightarrow A_1$ phosphorescence transition is calculated to be $\tau \cong 1 \times 10^{-2}$ sec. The calculated value for τ is in agreement with the experimental values for the related molecules $(CH_3)_2CO$, $(C_6H_5)_2CO$, and $C_6H_5COCH_3$, insofar as a comparison can be made. It is further shown that the spin–orbit perturbation in the $\pi \rightarrow \pi^*$ transitions of aromatic hydrocarbons should be about one thousand times less effective than the spin–orbit perturbation in the $n \rightarrow \pi^*$ transitions of carbonyl compounds. This is in agreement with the few pieces of experimental data which have been reported thus far.

539.19

739. AN APPLICATION OF THE THOMAS–FERMI METHOD TO COMPLEX IONS.
H.Kamimura, S.Koide, S.Sugano and Y.Tanabe.
J. Phys. Soc. Japan, Vol. 13, No. 5, 464-73 (May, 1958).

Although the covalency character has been found even in the normal complexes by analyses of paramagnetic resonance spectra and optical absorption experiments no reliable model for the electronic structures of complex ions has yet been established. To clarify this problem, the electron distribution in a complex ion $[Co(NH_3)_6]^{3+}$ is determined by means of the Thomas–Fermi method. To avoid the difficulty of the multi-centre problem, the smoothing approximation is adopted. The Thomas–Fermi equation is re-examined from the standpoint of the variation principle, in order to investigate the validity of this approximation. By the use of a trial function of spherical symmetry, the charge distributions for the total, valence- and core-electrons are calculated. Among these charge distributions, the charge distribution for valence-electrons seems most reliable and to approximate the real situation in the complex ion.

539.19

740. ELECTRON SPIN RESONANCE SPECTRA OF THE NH_2 AND ND_2 FREE RADICALS AT 4.2° K.
S.N.Foner, E.L.Cochran, V.A.Bowers and C.K.Jen.
Phys. Rev. Letters, Vol. 1, No. 3, 91-2 (Aug. 1, 1958).

NH_2 and ND_2 radicals were produced in a matrix of argon at 4.2° K by photolysis, with 1849 A radiation, of NH_3 and ND_3. Electron spin resonance of these radicals was observed at 4.2° K, and the identification of the radicals established by a detailed analysis of the hyperfine structure. J.M.Baker

539.19

741. ELECTRON RESONANCE SPECTROMETER FOR THE INVESTIGATION OF ORGANIC FREE RADICALS.
R.J.Abraham, D.W.Ovenall and D.H.Whiffen.
Trans Faraday Soc., Vol. 54, Pt 8, 1128-32 (Aug., 1958).

An electron resonance spectrometer for routine work using 9200 Mc/s radiation and pen-recording of the derivative of the absorption curve is described. The advantages of this presentation for organic free radicals and the performance of the spectrometer are discussed.

539.19

742. CALCULATION OF THE NUCLEAR MAGNETIC SHIELDING CONSTANT FOR CERTAIN MOLECULES.
I.V.Aleksandrov.
Dokl. Akad. Nauk SSSR, Vol. 121, No. 5, 823-6 (1958). In Russian.

An extension of previous work (Abstr. 7460/1958) to enable practical calculations of the shielding constant to be made for complex molecules. W.O.Lock

539.19

743. HIGH RESOLUTION SPECTRUM OF PROTON RESONANCE IN BENZENE. S.Fujiwara, M.Katayama, S.Hayashi and H.Shimizu.
Proc. Japan Acad., Vol. 34, No. 7, 432-4 (July, 1958).

539.19

744. PROTON MAGNETIC RESONANCE OF THE CH_3 GROUP. IV. CALCULATION OF THE TUNNELING FREQUENCY AND OF T_1 IN SOLIDS. E.O.Stejskal and H.S.Gutowsky.
J. chem. Phys., Vol. 28, No. 3, 388-96 (March, 1958).

For Pt III see Abstr. 9775 (1955). The thirty lowest eigenvalues of the Mathieu equation have been calculated numerically to nine places for a hindered rotor with threefold symmetry attached to a rigid framework. The results are tabulated for eight values of $IV_0/2\hbar^2$ ranging from 56.25 to 115.3125. The splittings of the torsional states of the CH_3 group have been used to calculate the average tunnelling frequency, ν_t, as a function of temperature for barrier heights of 825 cm^{-1} to 2770 cm^{-1}. Some useful relations are developed between the eigenvalues and torsional splittings for the 2- and 3-nodal potential functions. The B.P.P. theory (Abstr. 2529/1948) is used to calculate the proton spin–lattice relaxation time, T_1, for CH_3 groups undergoing hindered reorientations in solids and also overall molecular tumblings, assuming Debye spectral density functions for both motions. The manner in which the tunnelling affects T_1 is considered at some length and two ways of introducing it are described. The coupling among the three protons within a given CH_3 group is discussed briefly in relation to T_1.

539.19

745. INVESTIGATION BY NUCLEAR MAGNETIC RESONANCE OF THE EFFECTS OF PRESSURE ON THE THERMAL TRANSITION AND ROTATOR PHASE OF 2,2-DINITROPROPANE.
J.J.Billings and A.W.Nolle.
J. chem. Phys., Vol. 29, No. 1, 214-20 (July, 1958).

The thermal transition for 2,2-dinitropropane, which normally occurs at −5° C, is observed at various pressures up to 1000 kg/cm^2 in terms of the proton magnetic resonance line width. The spin–lattice relaxation time (T_1) is observed for temperatures from −11° C to 65° C, at atmospheric pressure and under 1000 kg/cm^2. The compressibility and the specific volume are measured, and X-ray powder patterns are compared, for temperatures above and below the transition. The latent heat of transformation and specific heat, above and below the transition, are calculated. Self-diffusion sets in at the transition, for all pressures studied. Under pressure, molecular rotation in the higher temperature phase is restricted and T_1 is insensitive to temperature. The correlation time for molecular rotation at atmospheric pressure and 50° C is 7×10^{-12} sec, in fair agreement with dielectric data. The temperature dependence of T_1 suggests that the fraction of molecules subject to rotation in the upper phase increases with the temperature.

539.19

746. ON THE EVALUATION OF MATRIX ELEMENTS OF THE HIGH-RESOLUTION N.M.R. SPIN HAMILTONIAN. P.L.Corio.
J. chem. Phys., Vol. 29, No. 3, 682-3 (Sept., 1958).

Some additional rules are given as aids in the analysis of spin–spin multiplets observed in high-resolution nuclear magnetic resonance spectra, in extension of the work of McConnell, McLean and Reilly (Abstr. 6927/1955). E.F.W.Seymour

539.19

747. SPIN DENSITIES IN THE PERINAPHTHENYL FREE RADICAL. H.M.McConnell and H.H.Dearman.
J. chem. Phys., Vol. 28, No. 1, 51-3 (Jan., 1958).

Valence bond theory is used to calculate π-electron spin densities (ρ_j) on carbon atoms in the perinaphthenyl free radical. The results are $\rho_1 = -0.176$, $\rho_2 = +0.321$, $\rho_3 = -0.220$, $\rho_{13} = +0.262$. The theoretical spin densities ρ_1 and ρ_2 are compared with the "experimental" values $|\rho_1| = 0.098$, $|\rho_2| = 0.325$ which are obtained from the equation $a_j = Q\rho_j$ and the absolute isotropic proton hyperfine splittings ($|a_1| = 2.2$, $|a_2| = 7.3$ gauss) which have been observed in the electron magnetic resonance of the perinaphthenyl free radical by Sogo, Nakazaki and Calvin. Valence bond theory thus yields calculated spin densities in this odd-alternate radical which are in reasonably good agreement with the "experimental" densities. Molecular-orbital theory without configuration interaction predicts only positive spin densities and is therefore inadequate to describe experimental densities in the perinaphthenyl radical or in any other substance with large negative spin densities.

539.19

748. MOLECULAR-ORBITAL TREATMENT OF ISOTROPIC HYPERFINE INTERACTIONS IN SIMPLE ALIPHATIC RADICALS.
D.B.Chesnut.
J. chem. Phys., Vol. 29, No. 1, 43-7 (July, 1958).

The problem of isotropic hyperfine interactions in the electron

paramagnetic resonance spectra of aliphatic free radicals is approached from the molecular-orbital picture of hyperconjugation. The ethyl, methylethyl, and 1, 1-dimethylethyl radicals are treated by this approximation; with a reasonable choice of parameters, the results can be correlated rather well with present knowledge of aliphatic radicals. The calculated coupling constants of methyl group hydrogens are of the order of 15 to 25 gauss, do not decrease radically with the presence of additional methyl groups, and are very nearly proportional to the molecular-orbital unpaired electron density at the central carbon atom.

539.19

749. STUDY OF THE NH RADICAL BY THE LCAO-SCF MOLECULAR ORBITAL METHOD. M.E.Boyd.
J. chem. Phys., Vol. 29, No. 1, 108-15 (July, 1958).

Wave-functions, orbital energies, and total molecular energies are obtained for the ground and five excited states of the NH radical. The Roothaan method was used, modified for the case of a molecule with unfilled orbitals. Separate self-consistent procedures were carried out for the ground state and a doubly excited state, while results for the intermediate excited states could be calculated with the ground state orbitals. Dissociation energies, dipole moments, and electron population analyses were also computed. Comparison with the sparse experimental data indicates that the calculated states are too widely separated in energy. It is also found that this complete treatment gives higher energy values than Higuchi reported in an incomplete computation employing various approximations, although the wave-functions are little changed. In general, results seem to be about as reliable for the diatomic open shell case as for the usual closed shell molecules. Contrary to Sahni's suggestion, they do not appear to be better for the heteronuclear than for the homonuclear case.

539.19

750. INTRAMOLECULAR TWISTING EFFECTS IN SUBSTITUTED BENZENES. II. GROUND-STATE PROPERTIES.
E.G.McRae and L.Goodman.
J. chem. Phys., Vol. 29, No. 2, 334-6 (Aug., 1958).

The effects on ground-state properties of twisting a substituent group about the substituent-ring bond in substituted benzenes are discussed from the viewpoint of semiempirical MO theory. The ground-state properties are discussed with reference to a parameter θ, which generally increases as the substituent is twisted. The substituent-ring bond order varies approximately as $\cos\theta$, and the following vary approximately as $\cos^2\theta$: the resonance energy, charge densities, ring C–C bond orders and the π-electronic dipole moment. The θ-dependence of the total dipole moment is discussed. Numerical applications to N, N-dimethylaniline and related molecules are described, including a detailed treatment of the dipole moments of N,N-dimethylaniline and some of its ortho-substituted derivatives. A brief discussion of the valence state of the dimethylamino group is included.

539.19

751. GENERALIZED UNITED-ATOM THEORY OF MOLECULES. I. SPHERICAL CONTRIBUTIONS IN THE $s\sigma$ WAVE FUNCTIONS FOR H_2^+. T.C.Chen.
J. chem. Phys., Vol. 29, No. 2, 347-55 (Aug., 1958).

The generalized united-atom view of molecules suggests that electronic states of symmetric molecules may be characterized by means of "atomic" quantum numbers. A test for the purity of the quantum number l in $s\sigma$ states in H_2^+ is facilitated by the Tibbs–Wannier theory of a Coulomb field with cutoff. Comparison shows that 96% of the ground state electronic energy is due to contributions of spherical functions.

539.19

752. GENERALIZED UNITED-ATOM THEORY. II. A ONE-CENTER MODEL FOR CYCLIC POLYENES. T.C.Chen.
J. chem. Phys., Vol. 29, No. 2, 356-61 (Aug., 1958).

In cyclic polyenes the quantum numbers of Hückel and Platt are related to the atomic magnetic quantum number m_l. A one-centre treatment shows that, within the tubular assumption, the lowest one-electron wave-functions have roughly the same (ρ,z) dependent part and are distinguished chiefly by the dependence on the azimuthal angle ϕ. The one-electron level scheme to first approximation is identical to that of Platt's electron-gas theory. Reintroduction of the lower molecular symmetry mixes states of different m_l and splits the $m_l = \pm(2N+1)$ degeneracy. The result is suggestive of the LCAO-MO theory, although the latter can be shown to be basically different. A semiempirical united-atom theory can be formulated in close parallel to the LCMO theory of Coulson, Longuet-Higgins and Dewar.

539.19 : 539.113

PARAMAGNETISM IN DIAMAGNETIC MOLECULES. See Abstr. 388

539.19 : 535.343

753. SPECTRAL COMPARISON OF POLYENES, CUMULENES, AND POLYYNES. H.Krauch.
J. chem. Phys., Vol. 28, No. 5, 898-9 (May, 1958).

If a double bond is introduced between two double bonds of a conjugated polyene to form a cumulene the λ maximum shifts by 34 mμ to longer wavelength. The conjugation is much smaller in polyacetylenes than in polyenes. The formulation of a cumulene structure for the ground state of long polyacetylenes seems to be incorrect.

539.19

754. AN ELECTROSTATIC MODEL FOR PREDICTION OF SHAPES OF COVALENT MOLECULES AND IONS. A.W.Searcy.
J. chem. Phys., Vol. 28, No. 6, 1237-42 (June, 1958).

For covalently bonded molecules and ions containing a central atom and one or more lone electron pairs, oxygen atoms, or sulphur atoms, bond angles can be predicted to within a few degrees by means of an electrostatic model. The parameters required are an electrostatic repulsion number (E.R.N.) for each substituent atom. These E.R.N.'s (except for that of fluorine) depend only on the chemical family of the substituent atom and on the period of the central atom. The model emphasizes the strong influence of lone pair electrons on molecular shapes, dipole moments, and other chemical and physical properties.

539.19

755. ROTATIONAL ISOMERISM IN 1-FLUORO-1,1,2,2-TETRACHLOROETHANE. R.E.Kagarise.
J. chem. Phys., Vol. 29, No. 3, 680-1 (Sept., 1958).

A study of the infrared spectrum of $CFCl_2-CHCl_2$, in conjunction with energy and bond moment calculations, suggest the existence of a single trans isomer having C_S symmetry and two equivalent skew forms of symmetry C_1. The latter seems to be the more stable and is thought to exist in both liquid and solid states.

G.I.W.Llewelyn

539.19 : 535.343

STRUCTURE OF CYCLOPROPYL DERIVATIVES. See Abstr. 203

539.19 : 537.523.4

MOLECULAR STRUCTURE OF HYDROCARBON GASES. See Abstr. 326

539.19

756. NEIGHBOR INTERACTIONS AND INTERNAL ROTATIONS IN POLYMER MOLECULES. I. STEREOSPECIFIC STRUCTURE AND AVERAGE DIMENSIONS. S.Lifson.
J. chem. Phys., Vol. 29, No. 1, 80-8 (July, 1958).

The skeletal bonds of vinylic polymer molecules are classified as (+) bonds and (–) bonds according to the arrangement of the side groups relative to the bonds. The detailed structure of isotactic and syndiotactic polymers is characterized by the different regularities of arrangment of these two bond types along the molecular chain. Symmetry properties of (+) and (–) bonds, and of (+) (+), (–) (–) and (–) (+) bond pairs, are discussed. These lead to relations between the average values of functions of the internal-rotation angles of the various bond-pairs. The end-to-end distance of isotactic and syndiotactic molecules is expressed in terms of bond lengths, bond angles, and internal rotation angles of the skeletal bonds, using methods of matrix algebra. The mean-square end-to-end distance $\langle h^2 \rangle$ of these molecules is determined by certain averages of trigonometric functions of the internal rotation angles enclosed between neighbouring skeletal bond pairs. The averages depend on the energy of interaction of neighbouring side groups as well as on the internal interactions within the skeletal bonds, and are different in the isotactic and syndiotactic molecules.

539.19

757. NEIGHBOR INTERACTIONS AND INTERNAL ROTATIONS IN POLYMER MOLECULES. II. POLYELECTROLYTES. S.Lifson.
J. chem. Phys., Vol. 29, No. 1, 89-97 (July, 1958).

The influence of the interaction between neighbouring ionizable groups of a polyelectrolyte molecule on the internal rotations around its skeletal bonds is considered. It is found that the repulsion between neighbouring groups tends to contract the molecule by twisting the molecular chain, and acts therefore against other forces which tend to extend the molecular dimensions. The quantitative

analysis is based on calculating a grand partition function of the polyelectrolyte molecule, in which both the energy of interactions within each bond and the energy of interaction between neighbouring ionizable groups are expressed as functions of the internal rotation angles. The grand partition function is used in obtaining the various averages of the trigonometric functions of the internal rotation angles which determine $\langle h^3 \rangle$ according to the results of Pt I (preceding abstract). These averages are given as functions of the degree of ionization of the macromolecule. The effect of the internal rotation of the skeletal bonds on the potentiometric titration and buffering capacity of polyelectrolyte solutions is discussed.

539.19

758. THEORY OF HYDROGEN DEUTERIDE IN MAGNETIC FIELDS. N.F.Ramsey and H.R.Lewis.
Phys. Rev., Vol. 108, No. 5, 1246-51 (Dec. 1, 1957).

The Hamiltonian for the diatomic $^1\Sigma$ heteronuclear molecule HD in a magnetic field is discussed. Included in the Hamiltonian are the effects of the nuclear and rotational magnetic moments interacting with the external magnetic field, magnetic shielding, molecular diamagnetism, and spin–spin magnetic interaction of the two nuclei, the interaction of the nuclear magnetic moments with the field due to the rotation of the molecule, the interaction of nuclear electric quadrupole moment, and the electron coupled nuclear spin–spin interaction. General expressions for the matrix elements of such a Hamiltonian are developed. Perturbation theory expressions for the energy of HD in the first rotational state are obtained in both strong- and weak-field limits. General expressions are given up to ninth order. The secular equation for HD is numerically solved for intermediate fields. Curves are given showing the theoretical dependence of the energy upon the field. Effects of zero-point molecular vibration and centrifugal stretching are discussed.

539.19

759. MOLECULAR BEAM RESONANCES IN OSCILLATORY FIELDS OF NONUNIFORM AMPLITUDES AND PHASES.
N.F.Ramsey.
Phys. Rev., Vol. 109, No. 3, 822-5 (Feb. 1, 1958).

Molecular beam resonances are discussed for molecules subjected to various combinations of nonuniform fixed and oscillatory fields. The transition probability equations are reduced to forms which are suitable for digital computer calculations. A Univac computer program for the calculation of the shapes of the resonances was developed which is applicable to systems involving simultaneous transitions between two or three different energy levels and to cases where the magnitudes of the fixed fields, the amplitudes of the oscillatory fields, and the phases of the oscillatory fields vary arbitrarily throughout the transition region. The calculation is applicable to systems perturbed at as many as nine different frequencies simultaneously and to arbitrarily determined molecular velocity distributions. Curves are shown for molecular beam resonances with two, three, and four separated oscillatory fields and for resonances with a gradually applied single oscillatory field. The effects of phase variation along the beam in distorting a separated oscillatory field resonance are discussed.

539.19

760. FREE RADICAL STATISTICS.
J.L.Jackson and E.W.Montroll.
J. chem. Phys., Vol. 28, No. 6, 1101-9 (June, 1958).

On the basis of a simplified statistical model, average concentrations of trapped free radicals condensed from a gaseous mixture are calculated. The trapped free radical concentration is obtained as a function of the free radical concentration in the gas and of the number of nearest neighbours in the solid. The mathematical problem presented by the model is solved rigorously in the one-dimensional case (two nearest neighbours) and approximately for arbitrary numbers of nearest neighbours. Typical calculated percentages of trapped free radicals range from 14% for a simple cubic lattice to 10% for a face-centred cubic lattice, when the solid is condensed from a completely dissociated gaseous mixture.

539.19

761. EXCITATION OF MOLECULAR VIBRATION ON COLLISION. M.Salkoff and E.Bauer.
J. chem. Phys., Vol. 29, No. 1, 26-31 (July, 1958).

The cross-section is calculated for excitation of the first vibrational level in the collision of two hydrogen molecules in the ground state. A partial wave analysis is used, and the radical equation is solved for many values of angular momentum using the high speed computer Univac. It is found that the major contribution to the total cross-section comes from large values of the angular momentum, of the order of 10 to 20, and that values of the angular momentum up to about 80 must be considered. In the energy range of interest, 0.5 to 2 eV, the total cross-section is obtained, and the vibrational relaxation time is also computed. The value of the cross-section is found by calculation to be very sensitive to the precise values of the intermolecular potential used.

539.19

762. ABSOLUTE CROSS SECTIONS FOR EXCITATION OF NITROGEN BY PROTONS OF A FEW keV ENERGY.
N.P.Carleton and T.R.Lawrence.
Phys. Rev., Vol. 109, No. 4, 1159-65 (Feb. 15, 1958).

Cross-sections for excitation by proton impact are necessary for quantitative interpretation of auroral spectra. These were measured for excitation resulting when protons of a few keV energy shoot into low-pressure nitrogen. Interference filters select various spectral features and a photomultiplier detects the light emitted. The light-detection apparatus is calibrated against a standard tungsten filament lamp. The measured cross-sections are not for the excitation of a given molecular level, but for a process resulting in the emission of one photon in a given transition. Cross-sections measured include: the 0,0 first negative band of N_2^+, λ3912; the 2,0 Meinel band of N_2^+, λ7850; a group of NI lines around λ8216; the Balmer line H_β; and the (4,2) and (3,1) first positive bands of N_2, excited by impact of fast atoms. Results are presented graphically, covering the range 1.5 to 4.5 keV. Also included are measurements of the total charge-exchange cross-section for protons in nitrogen and an estimate of the ionization cross-section.

539.19

763. TENSOR FORMALISM FOR COULOMB INTERACTIONS AND ASYMPTOTIC PROPERTIES OF MULTIPOLE EXPANSIONS.
L.Jansen.
Phys. Rev., Vol. 110, No. 3, 661-9 (May 1, 1958).

A tensor notation for electric multipole interactions between molecular charge distributions is developed and applied to the evaluation of first- and second-order interaction energies. An equivalence theorem between cylindrically symmetric and linear assemblies of charge is established. The mathematical implications of using a multipole Taylor expansion in regions of configuration space where the series has no validity is discussed for the first and second orders of perturbation theory.

539.19

764. SPECIFICITY OF CHARGE FLUCTUATION FORCES. I.
H.Jehle, J.M.Yos and W.L.Bade.
Phys. Rev., Vol. 110, No. 4, 793-800 (May 15, 1958).

Given a mixture of several types of molecule or macromolecule contained in a liquid medium, the question at issue is whether the forces, due to the interaction of fluctuating charge distributions in one molecule with those in an adjacent molecule, will cause preferential association of identical molecules or macromolecules from among that mixture. The fluctuating charge distributions in question may be due to quantum-mechanical fluctuations of charge distribution of electronic oscillators, as considered by London, Eisenschitz, and Wang, and they may also be due to fluctuations of distributions of mobile protons as investigated by Kirkwood and Shumaker.

539.19

765. SPECIFICITY OF CHARGE FLUCTUATION FORCES. II.
J.M.Yos.
Phys. Rev., Vol. 110, No. 4, 800-4 (May 15, 1958).

The problems discussed in Pt I (see preceding abstract) are treated on the basis of a general quantum mechanical model for the molecules.

539.19 : 533.21

INTERMOLECULAR FORCES AND COMPRESSIBILITY IN METHANE. See Abstr. 112

539.19

766. BOND DISSOCIATION ENERGY OF THE C_6H_5–F BOND.
P.Smith.
J. chem. Phys., Vol. 29, No. 3, 681 (Sept., 1958).

A value of 115 kcal $mole^{-1}$ is deduced for this bond energy and correlation with other published data on halogen compounds is attempted. G.I.W.Llewelyn

539.19

767. THE MAGNETIC SUSCEPTIBILITY OF OXYGEN IN A CLATHRATE COMPOUND. J.H.Van Vleck.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1236 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

539.19

768. THE CALCULATION OF THE MAGNETIC PROPERTIES OF MOLECULES USING THE METAL MODEL METHOD. II. T.K.Rebane.
Vestnik Leningrad Univ., (1957), No. 22, Ser. Fiz. Khim., No. 4, 70-5. In Russian.

For previous part see Abstr. 3436 (1958). The method is further developed and the results obtained compared with those of molecular-orbital theory. The theoretical principles are also given for an empirical rule (Veselov, and Rekasheva, ibid., (1954), No. 5, 149) for determining the form of the one-dimensional potential from the ionization potentials and the electron configuration of the atoms of conjugate systems. C.R.S.Manders

SOLID-STATE PHYSICS

539.2

769. METALLIC ALLOYS. J.Friedel.
Nuovo Cimento Suppl., Vol. 7, No. 2, 287-311 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

770. THE TRANSITION FROM THE METALLIC TO THE NON-METALLIC STATE. N.F.Mott.
Nuovo Cimento Suppl., Vol. 7, No. 2, 312-28 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

771. TRANSPORT PROPERTIES OF SOLIDS. J.M.Ziman.
Nuovo Cimento Suppl., Vol. 7, No. 2, 353-76 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

772. LOW TEMPERATURE BEHAVIOR OF DEBYE CHARACTERISTIC TEMPERATURES. G.K.Horton and H.Schiff.
Canad. J. Phys., Vol. 36, No. 9, 1127-30 (Sept., 1958).

The low-temperature behaviour of the characteristic Debye temperature is investigated using the six- and nine-direction Houston approximation and by way of illustration, the lattice dynamics of Born and Begbie (nearest neighbours only). The values of Θ_0 and B_2 for Cu, Au, Ag, Al, and Pb in the formula $\Theta_T = \Theta_0[1-B_2(T/\Theta_0)^2.....]$ were studied. The existence in Pb of a shallow maximum before the usual minimum, found earlier by Bhatia and Horton, is confirmed. The method is quite general and may be used for non-metals and with other theoretical models.

539.2

773. EVALUATION OF LATTICE INTERACTIONS IN OR NEAR A CUBIC CRYSTAL. G.S.Durham and B.A.Soderberg.
J. chem. Phys., Vol. 28, No. 6, 1201-6 (June, 1958).

Procedures, based on the methods of Madelung, are developed for the evaluation of lattice sums of inverse-power particle-interactions, λa^{-n}, at any point in or near a cubic crystal. Although not as elegant mathematically as those of Hove and Krumhansl, they are more complete in including the important cases of a point near a plane or line of particles, and are sufficiently simple in principle to be understood and applied by anyone with a background in differential calculus. Applications to a face-centered cubic ionic crystal are discussed and, as an example, the dipole—dipole van der Waals energy of a chloride ion before a NaCl half-crystal is calculated.

539.2 : 537.311.33

774. INDIRECT TRANSITIONS AT THE CENTER OF THE BRILLOUIN ZONE WITH APPLICATION TO InSb, AND A POSSIBLE NEW EFFECT. W.P.Dumke.
Phys. Rev., Vol.108, No. 6, 1419-25 (Dec. 15, 1957).

The theory of indirect optical transitions is extended to the case where both the valence and the conduction band extrema occur at the centre of the Brillouin zone. For this band structure, the dominant electron transition involves a virtual optical transition to a conduction band state, accompanied by scattering to a real state in the conduction band by absorption of a long-wavelength optical mode phonon. An analogous transition may also occur for holes. It is likely that the hole transition will be dominant over the electron transition when the curvature of the conduction band is greater than that of the valence band. It is shown that the absorption edge data on InSb are in agreement with this theory. The experimental evidence on InSb is reviewed and found to be consistent with degenerate valence bands at the centre of the Brillouin zone. The absence of any evidence of indirect transitions involving acoustic modes tends to indicate that the shift of the valence maximum away from $k = 0$ due to spin-orbit energy terms is small. A new effect is predicted involving the modulation of the indirect absorption constant by the selective excitation of the long-wavelength optical modes. A simplified theory of this effect is presented and the experimental possibilities of observing it in InSb are discussed. Its existence would verify the proposed indirect transition process as well as indicating the position of the band extrema.

539.2

775. MEASUREMENT OF LATTICE VIBRATIONS IN VANADIUM BY NEUTRON SCATTERING.
C.M.Eisenhauer, I.Pelah, D.J.Hughes and H.Palevsky.
Phys. Rev., Vol. 109, No. 4, 1046-51 (Feb. 15, 1958).

The energy spectrum of slow neutrons inelastically scattered by vanadium metal was measured by the time-of-flight technique. The neutrons gain energy by absorbing quanta of lattice vibration energy (phonons). As the nuclear scattering amplitude of vanadium is incoherent, the energy distribution of scattered neutrons is directly related to the frequency distribution of lattice vibrations. The measured neutron energy spectrum, as well as the derived frequency distribution, shows a clearly resolved double peak. This structure, which is distinctly different from the simple Debye distribution, but expected on the basis of detailed calculations, has heretofore not been amenable to direct measurement. The measured frequency distribution is compared with calculations for a body-centered cubic lattice by the Born—von Kármán theory and qualitative agreement is obtained. A more exact comparison awaits measurement of the elastic constants of vanadium.

539.2

776. COULOMB INTERACTIONS IN THE UNIFORM-BACKGROUND LATTICE MODEL. C.B.Clark.
Phys. Rev., Vol. 109, No. 4, 1133-41 (Feb. 15, 1958).

The uniform-background lattice model consists of a body-centred cubic lattice of point charges of like sign embedded in a uniform background charge of the opposite sign. The method used by Fuchs (Abstr. 4121/1935, 431, 4993/1936) to apply the Ewald sum formula to the case of static shear deformations is extended to apply to spatially periodic deformations. The dispersion relations (frequency as a function of wave-number) are presented for propagation vectors in the [100], [110], [111], and [210] directions. Comparison is made with the dispersion relations for the same directions in a Born—von Kármán model of a body-centred cubic lattice in which only central interactions between nearest and next-nearest neighbours are considered. The values of the "Coulomb part" of the macroscopic elastic constants as calculated by Fuchs are used for this model. The problem of treating a model in which the background responds to the displacement of point charges is discussed.

539.2

777. STORED ENERGY AND RECRYSTALLIZATION.
H.L.Walker and D.L.Bhattacharya.
J. Indian Inst. Sci. B, Vol. 37, No. 3, 179-85 (July, 1955).

Simple statistical considerations show that the recrystallized grain size of a deformed single crystal of a metal can be expressed as a function of the potential energy stored within the metal as a result of the deformation. A parabolic relation between the stored energy and the magnitude of the deformation is suggested and a formula relating recrystallized grain size with deformation is derived, which agrees with the empirical rule formulated by Walker.

539.2 : 536.413.2

778. ON NEGATIVE VOLUME EXPANSION COEFFICIENTS. M.Blackman.
Phil. Mag. (Eighth Ser.), Vol. 3, 831-8 (Aug., 1958).

It is shown that the Grüneisen constant derived from the elastic properties of a solid can be negative in certain cases. The lattice models examined are (a) ionic lattices with the zinc-blende structure, (b) ionic lattices with the rocksalt structure. In the first case it is found that a negative value is obtained over the whole range of parameters examined. In the second, negative values are obtained when the shear modulus of the lattice is sufficiently small. In all these cases the volume expansion coefficient of the cubic lattice would be negative at sufficiently low temperatures.

539.2 : 536.413.2

THERMAL EXPANSION OF KBr, KCl, NaCl FROM LIQUID AIR TEMPERATURE TO 300°C. See Abstr. 254-5

539.2

779. THE ELECTROSTATIC TERM IN THE SURFACE ENERGY. F.Bertaut.
C.R. Acad. Sci. (Paris), Vol. 246, No. 25, 3447-50 (June 23, 1958). In French.

Derives a formula for the surface energy applicable to any lattice. An infinity which arises in the case of charged surfaces is investigated. D.M.Edwards

539.2

780. ELECTRONS AND PLASMONS. D.Pines.
Nuovo Cimento Suppl., Vol. 7, No. 2, 329-52 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

781. BAND STRUCTURE OF RHOMBOHEDRAL GRAPHITE. R.R.Haering.
Canad. J. Phys., Vol. 36, No. 3, 352-62 (March, 1958).

The structure was investigated using the nearest-neighbour tight-binding approximation. The resulting behaviour of the π-bands near the Fermi surface is more complex than in the case of the Bernal stacking. The two π-bands still touch, but the touching points no longer lie on the edges of a hexagonal prism in k-space. Instead, they lie on cylinders whose axes are the edges of the hexagonal prism. The radii of these cylinders are proportional to γ_1, the nearest "out-of-plane" exchange integral. The de Haas–Van Alphen effect in the rhombohedral structure may be expected to yield useful information about the magnitude of γ_1.

539.2

782. ELECTRONIC ENERGY BANDS IN ZnS: POTENTIAL IN ZINCBLENDE AND WURTZITE. J.L.Birman.
Phys. Rev., Vol. 109, No. 3, 810-17 (Feb. 1, 1958).

This paper reports on the calculation of the crystal potential in ZnS. Experimental evidence relating to the nature of the chemical bond is reviewed, and it is concluded that the bonding is a mixture of covalent and ionic with effective charges of $+\frac{1}{2}$ for Zn, $-\frac{1}{2}$ for S. Radially symmetric sp^3 valence electron densities are constructed for each ion and normalized within each equivalent volume sphere to the appropriate net ion charge. It is concluded that the same charge densities are appropriate for zinc blende and wurtzite. Calculation using these charge densities then shows the crystal potential to be the same for both modifications in two corresponding prominent crystallographic directions. Hence, there is justification for using the same spherical potential for the cellular calculation of electronic energy bands in both structures. Finally, the close geometrical relationship of the two structures implies that many of the LCAO integrals which will arise in interpolating the band structures are identical.

539.2

783. ONE-DIMENSIONAL IMPURITY BANDS. M.Lax and J.C.Phillips.
Phys. Rev., Vol. 110, No. 1, 41-9 (April 1, 1958).

The density of states of one-dimensional crystals consisting of δ-functions randomly distributed was calculated on the IBM 650 computer. The chains contained 500-1000 impurity atoms, and the most probable error in the integrated density of states at various energies was estimated to be at most 0.5%. Calculations were performed for various values of the parameter $\epsilon = n/\kappa_0$, where n is the density of atoms and κ_0 the attenuation constant appropriate to the isolated bound state. The results at different densities are compared with those obtained from various physical models. At low densities the machine results display a singularity in the density of states at the isolated atom energy. For $\epsilon \ll 1$, a simple pair theory fits the machine results quantitatively in the wings and displays a similar singularity. At high density ($\epsilon \gg 1$) the machine results are smooth and fitted well by a crude optical model, except for a tail below the band edge omitted by the latter. An optical model containing local density fluctuations provides a qualitative understanding of the tail and a fair over-all fit for $\epsilon > \sim 1$.

539.2

784. A NOTE ON THE CELLULAR METHOD FOR ENERGY BANDS IN SOLIDS. L.Pincherle.
Proc. Phys. Soc., Vol. 72, Pt 2, 281-3 (Aug., 1958).

The various procedures that have been suggested for satisfying the boundary conditions in the cellular method are tested in a simple case with the empty lattice test. L.Pincherle

539.2

785. THE THEORY OF THE EXCITON IN SOLIDS. H.Haken.
Fortschr. Phys., Vol. 6, No. 6, 271-334 (1958). In German.

Detailed review and analysis of the behaviour of excitons in solids. Topics included are: (a) Localized excitons; semi-classical and quantum mechanical treatment. (b) Non-localized excitons in a fixed lattice; Schrödinger equation and translation invariance, approximations for the partition functions, the two-body approximation, exciton transport, asymptotic orthodox solutions for large distances, optical selection rules, interactions between electrons and excitons — particularly at crystal defects, magnetic properties of excitons. (c) Non-localized excitons in a deformed lattice; general wave equation and translation invariance, approximate solutions, a variational principle for the summing of states, the mean free path of excitons, diffusion of excitons. C.A.Hogarth

539.2

786. THE METHOD OF TRACES IN THE EXCITON PROBLEM. I.M.Dykman.
Zh. tekh. Fiz., Vol. 27, No. 8, 1731-43 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1609-21 (Aug., 1957).

The paper analyses excitons in ionic crystals by means of the method of traces. The interaction of an electron and a hole with lattice vibrations is taken into account. The statistical sum of the system is computed. The energy of the ground level and of the first excited level of the system are determined with an accuracy of up to the second-order infinitesimals. The temperature dependence of the energy of the ground state is found. It is shown that the energy variation at low temperatures is determined primarily by the weakening of the interaction between charged particles and the field of polarized vibrations when the temperature is increased, and not by increase of the kinetic energy. The effective exciton mass is computed in order to describe its progressive motion.

539.2

787. SUGGESTION CONCERNING THE ROLE OF WAVE-FUNCTION SYMMETRY IN TRANSITION METALS AND THEIR ALLOYS. J.B.Goodenough.
J. appl. Phys., Vol. 29, No. 3, 513-15 (March, 1958).

Past attempts to describe the d-electrons of the transition metals were based on one or the other of two extreme views: the one, the conduction-band model, treats the d-electrons as though they belong to the lattice as a whole rather than to particular atoms; the other, the shell model, treats the d-electrons as though they are completely localized. The purpose of this paper is to point out that the relative symmetries of d wave-functions and the lattice geometry should determine which d-electrons may be approximated by a localized, or shell, model, which electrons would be better approximated by bonding molecular orbitals, and which electrons may be treated by the conduction-band approximation. The b.c.c. metals are particularly discussed since in this lattice geometry, two of the d wave-functions are directed toward next-nearest neighbours and away from the eight nearest neighbours whereas three of the wave-functions are strongly perturbed by the nearest neighbours. It is pointed out that electrons which occupy states involving the former wave-functions should be localized whereas electrons which occupy states involving the latter wave-functions are best described by a molecular orbital: it is further pointed out that a possible description of the molecular orbitals in question is a bonding t_{2g} band. In this model the conduction band is a valence band composed of an s and three p orbitals. From a knowledge of the Hall constants and the magnetic characteristics of chromium and iron, a schematic density-of-states curve is constructed.

539.2

788. CYCLOTRON RESONANCE IN CRYSTALS. C.Kittel.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1140-7 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August, 1956.

539.2

789. MOBILITY OF ELECTRONS IN THE SILVER HALIDES. F.C.Brown.
Nuovo Cimento Suppl., Vol. 7, No. 2, 600-4 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2 : 539.12

790. CHARACTERISTIC ENERGY LOSS OF ELECTRONS IN GRAPHITE. Y.H.Ichikawa.
Phys. Rev., Vol. 109, No. 3, 653-7 (Feb. 1, 1958).

The problem of analysing the characteristic energy loss of

electrons in solids is discussed in some detail. Based on the general discussion given in the paper, the observed 7.5 eV loss line of graphite is tentatively identified as due to the collective excitation of π-electrons. The theoretical analysis gives results which strongly favour this identification. Furthermore, it is shown that the present theory together with detailed experimental studies is very useful for the determination of the π-electron band structure of graphite.

539.2

791. THE ELASTIC MODEL OF LATTICE DEFECTS. J.D.Eshelby.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 1-3, 116-21 (1958).

It is shown that between rigid misfitting spheres in an elastic continuum there is a repulsive interaction if the spheres are bonded to the medium. The effect of other boundary conditions is discussed, and a simplified method is given for calculating the interaction between various types of defect.

539.2 : 539.374

792. ARRANGEMENTS OF DISLOCATIONS IN PLASTICALLY BENT SILICON CRYSTALS. J.R.Patel.
J. appl. Phys., Vol. 29, No. 2, 170-6 (Feb., 1958).

Dislocations introduced into single crystals of silicon by plastic bending at an elevated temperature were studied quantitatively by the etch-pit technique. The average etch-pit density after deformation is approximately two to three times higher than the calculated dislocation density. Prolonged annealing of the deformed samples at a temperature close to the melting point results in polygonization or the alinement of etch pits perpendicular to the active slip planes. Satisfactory agreement was obtained between the densities of etch pits in the annealed and polygonized specimens and the predicted dislocation densities. Piled-up horizontal arrays of etch pits were observed in lightly bent samples. The value of yield stress obtained from the geometrical distribution of these arrays is an order of magnitude below the reported experimental values. Dislocation lines in single crystals deformed at 1000°C were revealed by the technique of copper decoration. Examination of the decorated samples by infrared transmission microscopy revealed that the dislocation lines lie in the [211] direction.

539.2

793. DETECTION OF SCREW DISLOCATIONS IN α-Al_2O_3 WHISKERS. R.D.Dragsdorf and W.W.Webb.
J. appl. Phys., Vol. 29, No. 5, 817-19 (May, 1958).

An X-ray method was developed for the detection of screw dislocations in whiskers, and proved satisfactorily on α-Al_2O_3 whiskers in which the screw dislocation is identified by an axial pore and the twist independently measured by optical methods.

539.2

794. THERMOELASTIC DISSIPATION DUE TO HIGH-SPEED DISLOCATIONS. J.H.Weiner.
J. appl. Phys., Vol. 29, No. 9, 1305-7 (Sept., 1958).

The thermoelastic dissipation due to an edge dislocation moving at an arbitrary speed is calculated analytically and numerical results are presented. It is found that, at usual stress levels, this mechanism has only a minor effect in limiting dislocation speed.

539.2

795. DISLOCATION THEORY. F.C.Frank.
Nuovo Cimento Suppl., Vol. 7, No. 2, 386-413 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

796. POINT IMPERFECTIONS IN SOLIDS. F.Seitz.
Nuovo Cimento Suppl., Vol. 7, No. 2, 414-43 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

797. EFFECTS OF CRYSTAL IMPERFECTIONS ON X-RAY DIFFRACTION. A.Guinier.
Nuovo Cimento Suppl., Vol. 7, No. 2, 444-79 (1958). In French.

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

798. LATTICE IMPERFECTIONS IN THIN LAYERS. R.Hilsch and W.Martienssen.
Nuovo Cimento Suppl., Vol. 7, No. 2, 480-97 (1958). In German.

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

799. DISLOCATIONS IN IONIC CRYSTALS. S.Amelinckx.
Nuovo Cimento Suppl., Vol. 7, No. 2, 569-9 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

800. ON SOME PHYSICAL CONSEQUENCES OF THE NON-LINEAR THEORY OF DISLOCATIONS. A.Seeger.
Nuovo Cimento Suppl., Vol. 7, No. 2, 632-45 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

801. DISLOCATIONS IN GERMANIUM AND SILICON. H.G.van Bueren, J.Hornstra and P.Penning.
Nuovo Cimento Suppl., Vol. 7, No. 2, 646-60 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2 : 548.7

802. THE THEORY OF SMALL ANGLE SCATTERING FROM EXTENDED DISLOCATIONS. H.H.Atkinson and P.B.Hirsch.
Phil. Mag. (Eighth Ser.), Vol. 3, 862-6 (Aug., 1958).

The theory of small-angle scattering from dislocations (see Abstr. 2034/1958) was extended to take into account the splitting of dislocations into partial dislocations. At very small angles the splitting does not change the scattered intensity, but its effect becomes important as the angle increases till at large angles the intensity is reduced to $\frac{2}{3}$ of its value at zero angle. It is suggested that it may be possible to determine the widths of extended dislocations from the shape of experimental scattering curves for deformed metals.

539.2 : 536.413.3

803. USE OF THERMAL EXPANSION MEASUREMENTS TO DETECT LATTICE VACANCIES NEAR THE MELTING POINT OF PURE LEAD AND ALUMINUM. R.Feder and A.S.Nowick.
Phys. Rev., Vol. 109, No. 6, 1959-63 (March 15, 1958).

Dilatometric and X-ray measurements of the thermal expansion of pure lead and aluminium were carried out between room temperature and the melting point. For lead, the results obtained by the two techniques agree within experimental error, which is interpreted to imply that the vacancy concentration at the melting point is (in mole fraction) less than or equal to 1.5×10^{-4}. For aluminium the dilatometric expansion appears to be slightly greater than the X-ray expansion. If this discrepancy is real, it corresponds to a vacancy concentration at the melting point of aluminium of about 3×10^{-4}. The corresponding estimate for the formation energy, ϵ_v, of a vacancy in lead is $\epsilon_v \geq 0.53$ eV, and in aluminium, $\epsilon_v = 0.77$ eV.

539.2

804. ENERGY RELEASED ON ANNEALING QUENCHED-IN DEFECTS IN GOLD. W.DeSorbo.
Phys. Rev. Letters, Vol. 1, No. 7, 238-9 (Oct. 1, 1958).

Preliminary measurements of the heat evolved during the annealing of gold quenched from high temperatures are reported; a typical value is 1.7 cal/g atom after quenching from 860°C. The results are interpreted in terms of vacancies and vacancy clusters trapped during quenching and destroyed on annealing. Comparison with other work on excess resistance of quenched gold wires leads to an estimate of 2.4×10^{-6} ohm cm per atomic% for the resistivity of vacancies in gold. H.Mykura

539.2

805. DISLOCATIONS AND SELECTIVE ETCH PITS IN InSb. J.D.Venables and R.M.Broudy.
J. appl. Phys., Vol. 29, No. 7, 1025-8 (July, 1958).

A special type of dislocation etch pit was observed in InSb, which illustrates the polarity of the zincblende structure and the nature of dislocations therein. The dislocation direction and slip plane were found to be $\langle 110 \rangle$ and $\{111\}$ respectively. Dislocations introduced by plastic bending at 450°C were observed by selective etch pits on $\{110\}$ faces. The etch pits are "arrow" shaped and all point in the same $\langle 100 \rangle$ direction regardless of bending direction. The $\{110\}$ pits develop for only one of two possible types of 60° dislocation which exist in the zincblende structure. One type terminates in a row of In atoms, the other in a row of Sb atoms.

539.2

806. DISLOCATION ETCH PITS IN ANTIMONY. J.H.Wernick, J.N.Hobstetter, L.C.Lovell and D.Dorsi.
J. appl. Phys., Vol. 29, No. 7, 1013-18 (July, 1958).

Pits, which are probably the sites of dislocations, were produced

on the (111) cleavage planes of antimony by use of the CP4 etching reagent. Evidence that the pits probably are at dislocation sites was obtained from density counts on intersecting boundaries and from deformation and annealing studies. The Dash etching reagent chemically polishes antimony without producing pits. The Superoxol etch brings out spiral terraced pits and other fine structure.

539.2

807. DISLOCATION ETCH PITS IN GERMANIUM.
W.Bardsley, R.L.Bell and B.W.Straughan.
J. Electronics and Control, Vol. 5, No. 1, 19-28 (July, 1958).

The influence of the direction of the dislocation line on the shape of the etch pits produced by CP4 on {111} faces of germanium single crystals is examined. The azimuth but not the declination of the dislocation line may be derived from the etch pit shape. Observations of the azimuth and the trace direction have been used to identify the direction of the dislocation lines in some crystals.

539.2 : 537.311.33

EFFECT OF DISLOCATIONS ON BREAKDOWN IN SILICON P–N JUNCTIONS. See Abstr. 315

539.2

808. ANISOTROPIC COLOR CENTERS IN α-QUARTZ. II. GERMANIUM-DOPED SYNTHETIC QUARTZ.
A.J.Cohen and H.L.Smith.
J. chem. Phys., Vol. 28, No. 3, 401-5 (March, 1958).

For Pt I, see Abstr. 2827 (1957). The colour centre at 275 mμ produced by X-irradiation in three specimens, two of Bell and one of Clevite synthetic quartz, depends on the presence of germanium impurity. It is absent in specimens free of germanium. The centre is anisotropic with maximum absorption in the σ direction (electric vector perpendicular to the c axis). In the π direction (electric vector parallel to the c axis) the absorption is poorly resolved into two bands. The colour centre absorption is caused by an electric dipole transition. This centre bleaches more rapidly than other colour centres present in the specimens. This colour centre system is accompanied by the aluminium system which is in the 460 mμ region and by two other bands at 1900 and 2050 A. No relationships were observed among these bands other than that they are found together in the three instances studied and the intensity increases with the energy of the given band. A question of a model for this centre is discussed.

539.2

809. COLOR CENTERS IN ALKALI HALIDES. H.Pick.
Nuovo Cimento Suppl., Vol. 7, No. 2, 498-522 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

810. ANISOTROPY OF COLOUR CENTRES IN ALKALI HALIDES. C.Z. van Doorn.
Philips Res. Rep., Vol. 12, No. 4, 309-23 (Aug., 1957).

Additively coloured crystals of KCl and NaCl, which have been irradiated in the F-band at room temperature, show, in addition to the F-band, absorption bands which are due to M- and R-centres. Irradiation in these bands with polarized light at 77°K produces an unpolarized infrared emission due to F-centres and two infrared emission bands, due to M- and R-centres, showing polarization. The degree and directional properties of this polarization depend on the type of centre and method of excitation. Irradiation with polarized light in the F-band also induces dichroism in the F- and M-bands. Models for the centres are discussed which may explain these phenomena.

539.2

811. COLOUR CENTERS IN SYNTHETIC FLUORITE CRYSTALS. W.Bontinck.
Physica, Vol. 24, No. 8, 639-49 (Aug., 1958).

A study of the coloration of fluorite crystals after irradiation and additive coloration was made. Bleaching experiments and lattice parameter measurement suggest probable models for the α- and β-centres. The β-centre should be a normal F-centre, the α-centre an F-centre coupled to an interstitial fluorine ion.

539.2

812. THE ELECTRONIC STRUCTURE OF A V-CENTER.
T.G.Castner, W.Känzig and T.O.Woodruff.
Nuovo Cimento Suppl., Vol. 7, No. 2, 612-19 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2

813. ON DAS' THEORY OF NUCLEAR MAGNETIC RESONANCE IN SOLIDS. J.W.McGrath and A.A.Silvidi.
J. chem. Phys., Vol. 29, No. 1, 103-5 (July, 1958).

Das' theory developed the effect of vibratory rotary motion of water molecules in crystalline hydrates on the resonance spectra of the protons. Limitations on applicability of this theory are discussed. The theory is extended to the general case and a further effect on spectra is obtained. This effect is dependent upon the orientation of the proton–proton axis within the crystal, the orientation of the crystal in the magnetic field, the temperature and the height of the twofold potential barrier containing the water molecule. Partial experimental support of the theory is cited. Two methods for measuring proton–proton separations that do not require Das' theory corrections are described. A method for measuring the height of the potential barrier is described.

539.2 : 539.14

814. NUCLEAR MAGNETIC RESONANCE IN SEMICONDUCTORS. III. EXCHANGE BROADENING IN GaAs AND InAs.
R.G.Shulman, B.J.Wyluda and H.J.Hrostowski.
Phys. Rev., Vol. 109, No. 3, 808-9 (Feb. 1, 1958).

Nuclear magnetic resonance lines were observed for the more abundant isotopes of the semiconductors GaAs and InAs. The resonances are broader than expected from nuclear dipolar widths alone. The additional broadening is explained by the indirect nuclear exchange mechanism and is consistent with previous measurements on the homologous semiconductors InSb and GaSb.

539.2 : 538.113

815. NUCLEAR RELAXATION IN MAGNETIC MATERIALS.
J.Van Kranendonk.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1192-3 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

539.2

816. EXPERIMENTAL STUDY OF SPIN–LATTICE RELAXATION TIMES IN ARSENIC-DOPED SILICON.
J.W.Culvahouse and F.M.Pipkin.
Phys. Rev., Vol. 109, No. 2, 319-27 (Jan. 15, 1958).

Measurements of the spin–latice relaxation times of arsenic donors in a doped silicon crystal at 8500 gauss and 1.3°K are reported. The relaxation times for the stable As^{75} were measured by using adiabatic fast-passage techniques to observe the relative amplitudes of the electron resonance signals as a function of time. The relaxation times for the radioactive As^{76} were measured by observing the formation and decay of the nuclear alignment. For the As^{75}, of which there are 2.8×10^{16} atoms/cm^3, the direct electron relaxation time is 6.5 ± 0.5 minutes and the relaxation time for simultaneous spin-flips of the nucleus and the electron is 4.7 ± 1 min. For the As^{76}, of which there are 3×10^{10} atoms/cm^3, the direct electron relaxation time is 4 ± 2 minutes and the relaxation time for simultaneous spin-flips of the nucleus and the electron is ≥ 75 minutes.

539.2

817. SPIN-LATTICE RELAXATION. M.W.P.Strandberg.
Phys. Rev., Vol. 110, No. 1, 65-9 (April 1, 1958).

The measurement of electron spin–lattice relaxation times for paramagnetic crystals at low temperatures is complicated by the fact that the spin specific heat can be much larger than the lattice specific heat. At low temperatures direct processes dominate in the spin–lattice relaxation mechanism and evidence exists that indicates that only a narrow portion of the phonon spectrum takes part in the relaxation processes. This situation is not encompassed by usual treatments of the spin–lattice problem and a microscopic treatment is presented which allows for this selective excitation of of the phonon spectrum. It is pointed out that phonon relaxation times can be the dominant quantity measured in the usual saturation spin–lattice relaxation measurements. The analysis indicates how pulse measurements may be used to evaluate the actual spin–lattice relaxation time independent of the phonon relaxation time. A discussion of some conditions under which the concept of temperature may be applied to quantum-mechanical systems interacting with electromagnetic fields, such as in solid-state amplifiers or absorbers, is given.

539.2

818. MULTIPLE ECHOES IN SOLIDS. I.Solomon.
Phys. Rev., Vol. 110, No. 1, 61-5 (April 1, 1958).

By the study of the Zeeman resonance of a nucleus having a large quadrupole moment, like iodine, Watkins and Pound (Abstr.

2549/1953) have shown that a cubic crystal like KI is never perfect, and that random electrical gradients always exist at the locations of the nuclei. However, by the c.w. method only a lower and upper limit can be set to the interaction of the quadrupole moment of the nuclei with these gradients. In order to get more information about their distribution, the spin-echo technique, with large r.f. field, was used. The calculations, performed in the limit of a field much larger that the random quadrupole interaction, show that, if at time t = 0 a 90° pulse is applied, and at time $t = \tau$ a φ pulse is applied (with an optimum for φ around $\pi/5$) one obtains: three "allowed" echoes, at times t such that $(t-\tau)/\tau = \frac{1}{2}$, 1 and 2, which are bell-shaped curves; two "forbidden" echoes for $(t-\tau)/\tau = \frac{3}{2}$ and 3, which are derivatives of bell-shaped curves. These predictions are in agreement with the experiment, and from the width of the allowed echoes, an average of the random quadrupole interaction can be determined: this average, expressed in gauss, was found to vary from 18 gauss to 36 gauss in different samples. One could verify, by using this method, that the crushing, as well as the quenching of the crystals increase the magnitude of the random gradients.

539.2 : 538.114

INTERACTION OF SPIN WAVES AND ULTRASONIC WAVES IN FERROMAGNETIC CRYSTALS. See Abstr. 411

539.2

819. ELECTRIC FIELD GRADIENTS IN IONIC CRYSTALS. I. NUCLEAR QUADRUPOLE COUPLING CONSTANTS. R.Bersohn.
J. chem. Phys., Vol. 29, No. 2, 326-33 (Aug., 1958).

In ionic crystals and metals the coupling constant of a quadrupolar nucleus can often be written in the simplified form $eQ(\Delta\mathcal{E})(1-\gamma_\infty)$. The polarization factors $1-\gamma_\infty$ were calculated in previous work by Das, Wikner and Bersohn. In the present work the factors $\Delta\mathcal{E}$ are calculated in the form of lattice sums. Under favourable circumstances a good estimate of the nuclear quadrupole moment Q can be made. When Q is known by other means, information about the distribution of charges in crystals may be obtained. It is shown, for example, that Al_2O_3 is essentially ionic. The agreement between experimental and observed coupling constants proves that the field gradients in ionic crystals and metals is of long-range origin in contrast to molecular crystals.

539.2

820. RÖNTGENOGRAPHIC AND PARAMAGNETIC RESONANCE EXPERIMENTS WITH (Gd-La)AlO_3 MIXED CRYSTALS.
H.Gränicher and K.A.Müller.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1216-19 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

539.2

821. CONCERNING AN EXPERIMENTAL VERIFICATION OF THE THERMODYNAMICAL THEORY OF SPIN–SPIN PARAMAGNETIC RELAXATION IN PARALLEL FIELDS. K.P.Sitnikov.
Zh. eksper. teor. Fiz., Vol. 34, No. 5, 1093-5 (1958). In Russian.

Paramagnetic spin–spin absorption in a number of substances at a frequency of 600 Mc/s at room temperature was studied experimentally. The absorption law which the Shaposhnikov theory yields (Abstr. 3829/1948) agrees satisfactorily with the experiments, if the corresponding relaxation time is considered to be independent of the magnitude of the constant field. The constant b/c was measured for some substances for which it has not been known previously.

539.2

822. PARAMAGNETIC LATTICE RELAXATION IN HYDRATED DIVALENT COPPER SALTS. Sh.Sh.Bashkirov.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1465-9 (1958). In Russian.

A theoretical calculation of the spin–lattice relaxation time in hydrated divalent copper salts is carried out. Anisotropy of the relaxation time experimentally observed in $CuSO_4.5H_2O$ crystals can be explained by taking into account anisotropy of the spin–orbit interaction in the Cu^{++} ion due to the partial covalent nature of the copper ion bonds in the crystal.

539.2

823. OPTICAL PROPERTIES OF SOLIDS. D.L.Dexter.
Nuovo Cimento Suppl., Vol. 7, No. 2, 245-86 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.21

824. RADIATION EFFECTS IN SOLIDS. R.Smoluchowski.
Nuovo Cimento Suppl., Vol. 7, No. 2, 523-43 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.21

825. INFLUENCE OF A VARIABLE EJECTION PROBABILITY ON THE DISPLACEMENT OF ATOMS. A.E.Fein.
Phys. Rev., Vol. 109, No. 4, 1076-83 (Feb. 15, 1958).

A model for the radiation-induced displacement of atoms is used in which each atom of a crystal has a threshold energy that is a random variable. Three quantities are derived as a function of the probability density of this random variable. First, the total number of displaced lattice atoms resulting from an initial energetic atom is found as a function of the kinetic energy of the moving atom. Second, the average number of displaced lattice atoms per atom initially displaced by external radiation is derived. Third, the total number of displaced atoms resulting from a given dose of radiation is determined. Both charged particle and neutron radiation are considered. It is shown that the shapes of all these quantities, for moderately large energies of the bombarding particles, are independent of the nature of the probability density governing the displacement energy; the probability density determines only an amplitude factor. It is shown further that the physical effects of bombardment by either neutrons or charged particles can be pictured as arising from an "effective sharp-threshold energy" determined by the probability density functions and that this effective threshold is the same for both types of bombardment. Finally, it is shown that, if the present factor of about five between the theory of radiation damage and the corresponding experiments is to be explained solely on the basis of a variable probability of ejection, a considerable fraction of the atoms in a solid must have a surprisingly large threshold energy.

539.21 : 537.311.33

826. LOW-TEMPERATURE IRRADIATION OF N-TYPE GERMANIUM. J.W.Cleland and J.H.Crawford, Jr.
J. appl. Phys., Vol. 29, No. 2, 149-51 (Feb., 1958).

The rate of change of conductivity of n-type single crystal plates of germanium at a temperature of ~16°K during fast neutron irradiation is enhanced over that previously observed at higher temperatures. Annealing studies subsequent to irradiation reveal no evidence of thermally unstable defect states between ~10 and ~95°K. Annealing above ~95°K indicates the presence of thermally unstable minority carrier traps of the type previously observed following irradiation at 120°K. The enhanced decrease in conductivity at 16°K compared with that observed at higher temperatures is believed to reflect a greater rate of introduction of defects, many of which anneal at temperatures above ~95°K.

539.21

827. DENSITY OF NEUTRON-IRRADIATED LITHIUM FLUORIDE CRYSTALS. J.Spaepen.
Phys. Rev. Letters, Vol. 1, No. 8, 281-2 (Oct. 15, 1958).

Density decreases of up to 23% of the original value were observed in small platelets irradiated in vacuum in B.R.1 reactor at about 80°C. The density decrease saturates at about 1.2×10^{18} nvt. Preliminary data on annealing behaviour of irradiated samples are given. J.Adam

539.21

828. RADIATION DAMAGE EXPERIMENTS AND THE NATURE OF THERMAL SPIKES IN III–V COMPOUNDS.
U.Gonser and B.Okkerse.
Phys. Rev., Vol. 109, No. 3, 663-7 (Feb. 1, 1958).

Specimens of gallium antimonide were irradiated at liquid-nitrogen temperature with 12 MeV deuterons. The results of resistivity measurements during irradiation and of X-ray observations after the irradiation suggest very strongly that "thermal spikes" (regions of local heating of the lattice) are introduced under these conditions. In particular from the shape and the intensity of the X-ray reflections the conclusion is drawn, that in these spike regions the material is present in a liquid-like lattice configuration, markedly different from the matrix configuration. The observations on annealing support the suggested model.

539.21

829. ELECTRON SPIN RESONANCE SPECTRA OF SOME γ-IRRADIATED POLYMERS. R.J.Abraham and D.H.Whiffen.
Trans Faraday Soc., Vol. 54, Pt 9, 1291-9 (Sept., 1958).

The electron spin resonance spectra of a number of γ-irradiated polymers, mostly of the polyvinyl series, were measured. The results are tabulated and the spectra shown. The appearance of a new spectrum on introducing air was noted in some cases. A few tentative interpretations of the hyperfine patterns are made.

539.21

830. ELECTRON RESONANCE STUDIES OF THE CHANGE IN FREE RADICAL SPECTRA OF SOLID ALCOHOLS WITH VARIATION OF TEMPERATURE AND TIME OF U.-V. IRRADIATION. M.Fujimoto and D.J.E.Ingram.
Trans Faraday Soc., Vol. 54, Pt 9, 1304-15 (Sept., 1958).

Summarizes the different types of change that are observed in free radical spectra when the condition of the trapping medium is altered. Hydroxyl radicals are formed initially by photo-dissociation, and these then produce secondary radicals by attack on hydrocarbon molecules. The latter are trapped in the viscous glass formed at low temperatures and it is found that the nature of the trapped radicals depends on the physical condition of the trapping medium. The different types of change which these spectra undergo, as the temperature of the glass is altered, can be grouped under several headings, and these are discussed in detail.

STRUCTURE OF SOLIDS

539.211

831. FRACTURE PHENOMENA AND MOLECULAR WEIGHT IN POLYMETHYL METHACRYLATE. S.B.Newman and I.Wolock.
J. appl. Phys., Vol. 29, No. 1, 49-52 (Jan., 1958).

Tensile specimens of cast polymethyl methacrylate of five different molecular weights varying from 90 000 to 3 160 000 were broken by static loading and the fracture surfaces compared. The fracture appearance was fairly constant for a given molecular weight but there was a continuous development of certain features and a retrogression of others with changes in molecular weight. The series, which was developed by varying the molecular weight, was similar in appearance to that developed by Zandman by varying the rate of loading of polymethyl methacrylate. The higher molecular weight specimens corresponded in appearance to those obtained at the lower rates of loading. In the higher molecular weights, failure by "separation" was most marked whereas fracture by "pulling out" of polymer masses became more important at the lower molecular weights.

539.211

832. HIGH-SPEED FRACTURE IN RUBBER. P.Mason.
J. appl. Phys., Vol. 29, No. 8, 1146-50 (Aug., 1958).

Cinematographic observations were made of crack propagation under well-defined boundary conditions in rubbers at speeds up to 60 m/sec. The fracture-markings showed resemblances to those obtained with metals, plastics, and glass, and could be related directly to the corresponding speed of fracture-propagation. In close analogy with Schardin's observations on glass, a noncrystallizing rubber (GR-S) showed a mode of crack propagation in which the fractured surfaces were visually smooth and the speed was about one quarter of the speed of longitudinal elastic waves. A crystallizing rubber (natural rubber) did not show this mode of propagation under the present test conditions. It is suggested that the modes of solid fracture can be usefully classified in three categories: (1) slow propagation, generally with smooth surfaces, obtained by careful control of the boundary conditions; (2) propagation at intermediate rates with rough surfaces, involving correspondingly greater energy consumption; and (3) fast propagation with smooth surfaces, the rate of propagation being limited by the speed of elastic waves in the material in accord with Mott's theory.

539.211 : 534.222.2

833. FRACTURES PRODUCED BY STRESS PULSES IN GLASS-LIKE SOLIDS. H.Kolsky and Y.Y.Shi.
Proc. Phys. Soc., Vol. 72, Pt 3, 447-53 (Sept., 1958).

Measurements were made of the amplitudes of the maximum tensile stress pulses which could propagate along rods of glass and of two glass-like plastics (polystyrene and polymethylmethacrylate) without producing fracture. Small quantities of explosive were detonated at one end of the rod so that a compression pulse travelled down the rod and on reflection at the opposite end returned as a tension pulse. The displacement–time curve of the free end was recorded with a condenser-microphone arrangement and the stress was obtained by differentiating this curve numerically. The maximum amplitudes were compared with the tensile strength of the specimen as measured in a standard tensile testing machine. Since the loading time with the stress pulses was only a few microseconds, the ratio of loading rates between the "static" and dynamic tests was of the order 10^6. For all three materials the dynamic value was about twice the static. In the two plastics, it was found possible to produce purely internal cracks which resulted from the slightly higher tensile stress in the interior of the rod. With glass no such internal cracks were observed. These results indicate that the strength of the plastics will not depend markedly on the surface condition of the specimen.

539.213.2 : 534.22

THE LIQUID–GLASS TRANSITION REGION. See Abstr. 135

539.215

834. ROUTINE APPARATUS FOR DETERMINING THE SURFACE AREA OF METAL POWDERS. P.Hersch.
J. Inst. Metals, Vol. 86, Pt 12, 509-11 (Aug., 1958).

A simplified version of the low-temperature, nitrogen-adsorption technique for determining the specific surface area of metal powders is described. The modified method involves determination of one point only of the adsorption isotherm; the dead space is estimated without the use of helium, and the amount of ancillary equipment required is much reduced. Five or six samples can be measured in one day, by a semi skilled operator, with results reproducible within ±5%.

539.217

835. DIFFUSION IN MULTICOMPONENT METALLIC SYSTEMS. I. PHENOMENOLOGICAL THEORY FOR SUBSTITUTIONAL SOLID SOLUTION ALLOYS. J.S.Kirkaldy.
Canad. J. Phys., Vol. 36, No. 7, 899-906 (July, 1958).

Onsager's generalization of Fick's law for diffusion in multicomponent systems is examined with a view to determining the conditions imposed on the diffusion coefficients by the second law of thermodynamics and by "microscopic reversibility". The generalized differential equations with constant coefficients, obtained by combining Fick's law and the continuity equations, are solved for the boundary conditions corresponding to the semi-infinite diffusion couple.

539.217

836. DIFFUSION IN MULTICOMPONENT METALLIC SYSTEMS. II. SOLUTIONS FOR TWO-PHASE SYSTEMS WITH APPLICATIONS TO TRANSFORMATIONS IN STEEL. J.S.Kirkaldy.
Canad. J. Phys., Vol. 36, No. 7, 907-16 (July, 1958).

The generalized differential diffusion equation for multicomponent systems with constant coefficients is solved for an advancing linear, cylindrical, or spherical two-phase interface. Representative numerical calculations for ternary alloys based on the iron–carbon system demonstrate how inhibition of the transformation austenite to ferrite + carbide can occur through the requirement of maintaining (extrapolated) equilibrium at the interface and through the interaction of carbon atoms with the off-diagonal gradients in the diffusion matrix. It is proposed that these interactions are the primary cause of hardenability effects in steel.

539.217

837. DIFFUSION IN MULTICOMPONENT METALLIC SYSTEMS. III. THE MOTION OF PLANAR PHASE INTERFACES. J.S.Kirkaldy.
Canad. J. Phys., Vol. 36, No. 7, 917-25 (July, 1958).

Onsager's phenomenological scheme is adapted to unidimensional diffusion in a multiphase, multicomponent system with constant diffusion coefficients. Subject to initial conditions corresponding to the semi-infinite diffusion couple, and exact solution of the multicomponent equations is obtained from which the planar interface motions can be calculated. The similar but unrelated motion of markers that occurs in the diffusion zone of some single-phase couples is discussed and Darken's phenomenological description for binary alloys is extended to multicomponent systems.

539.217

838. MEASUREMENT OF TERNARY DISTRIBUTION COEFFICIENTS IN SILICON. D.Navon.
J. appl. Phys., Vol. 29, No. 3, 579-82 (March, 1958).

A method is described for determining the distribution coefficient of an impurity introduced into a semiconductor by a fused metal contact. Coefficients for the segregation of antimony, arsenic, gallium, and aluminium from a silver contact to silicon at 1250° C are less than at the silicon melting point (1408° C). Gold-doped contacts to silicon yield similar values for the distribution coefficient of these impurities. This value is independent of the concentration of the impurity in the gold or silver alloy for small (less than 1%) percentages of the impurity. At 1250° C, the segragation of aluminium from a dilute solution of aluminium in silver is about the same as from 100% aluminium. The diffusivity of silicon atoms through a

liquid zone containing aluminium and saturated with silicon is greater, at any particular temperature, than the diffusivity through a silver-silicon zone at the same temperature. However, these values approach each other at the silicon melting point.

539.217

839. MODEL FOR SOLUTE DIFFUSION IN CRYSTALS WITH THE DIAMOND STRUCTURE. R.A.Swalin.
J. appl. Phys., Vol. 29, No. 4, 670-4 (April, 1958).

A theory for solute diffusion in crystals with the diamond structure such as germanium and silicon is derived by considering the effect of impurity ion size difference and also the coulombic interaction between impurity ions and charged vacancies. The theory is compared with experimental results reported for germanium and silicon and the agreement is considered quite good. The experimental observations that n-type impurities diffuse considerably faster than p-type impurities in germanium, whereas the opposite effect is observed in silicon, are explained by the theory. Because of the relation between the Fermi energy and vacancy acceptor level, the coulombic interaction is shown to be the predominating factor in germanium, whereas in silicon the size difference between impurity ions is shown to predominate.

539.217

840. DIFFUSION OF TUNGSTEN IN NICKEL AND REACTION AT INTERFACE WITH SrO: H.W.Allison and G.E.Moore.
J. appl. Phys., Vol. 29, No. 5, 842-8 (May, 1958).

Diffusion rates of tungsten in single crystal and polycrystalline nickel were measured at temperatures between 1100° and 1275°C by using radioactive W^{185} and a sectioning technique. Grain boundary diffusion was observed by use of radio-autographs. A simple vacancy mechanism accounts for nearly all of the diffusion; some refinement is required for the transport observed at greater depths. The rate of reaction of polycrystalline 4.9% tungsten–nickel alloy with SrO was measured by the hydrogen evolution technique at temperatures between 830° and 1280°C. The rate indicates that the production of Sr in amounts up to 200 $\mu g\ cm^{-2}$ is not limited by diffusion of tungsten in the nickel core.

539.217

841. DIFFUSION OF INDIUM IN TIN SINGLE CRYSTALS. A.Sawatzky.
J. appl. Phys., Vol. 29, No. 9, 1303-5 (Sept., 1958).

The rate of diffusion of indium in single crystals for two orientations was measured using the radioactive isotope In^{114}. The diffusion coefficients in the directions parallel to the a-axis and c-axis are given by the Arrhenius relations

$$D_a = 34.1 \exp(-25\,800/RT)\ cm^2\ sec^{-1}$$

$$D_c = 12.2 \exp(-25\,600/RT)\ cm^2\ sec^{-1}$$

The anisotropy is discussed in terms of the vacancy mechanism of diffusion.

539.217 : 539.374

842. ANALYSES FOR DIFFUSION DURING PLASTIC DEFORMATION. J.Simmons and J.E.Dorn.
J. appl. Phys., Vol. 29, No. 9, 1308-13 (Sept., 1958).

Presents the general equation for self-diffusion in deforming media. Methods of analyses for determining the self-diffusivity as a function of time for prescribed strain histories are given for special cases of linear diffusion. No unrealistic assumptions relative to the constancy of the diffusivity with time are made.

539.217 : 541.183.2

843. SURFACE DIFFUSION OF CO ON W. R.Gomer.
J. chem. Phys., Vol. 28, No. 1, 168 (Jan., 1958).

A field emission tube for surface diffusion studies is described. Diffusion of CO on W is similar to that of O_2 on W with approximately the same activation energy and heat of binding in the second layer. Desorption is rapid at 1300°K without carbon contamination which indicates that no dissociation occurred during the chemisorption process. G.I.W.Llewelyn

539.217

844. CORRELATION EFFECTS IN DIFFUSION IN SOLIDS. A.B.Lidiard.
Nuovo Cimento Suppl., Vol. 7, No. 2, 620-31 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.217

845. DIFFUSION OF IRON, COBALT, AND NICKEL IN SINGLE CRYSTALS OF PURE COPPER. C.A.Mackliet.
Phys. Rev., Vol. 109, No. 6, 1964-70 (March 15, 1958).

The rates of diffusion of radioactive tracers of Fe, Co, and Ni in single crystals of pure copper were measured as a function of temperature from about 700 to 1075°C. The results, obtained by the tracer-sectioning technique, are as follows:

$$D_{Fe\rightarrow Cu} = 1.4 \exp(-51\,800/RT);\ D_{Co\rightarrow Cu} = 1.93 \exp(-54\,100/RT);$$
$$D_{Ni\rightarrow Cu} = 2.7 \exp(-56\,500/RT);$$

all in units of cm^2/sec. An exploratory measurement for a Mn tracer in copper was made at 1069°C with the result $D = 1.49 \times 10^{-8}\ cm^2/sec$. The results of several current theoretical calculations are compared with the present data: Wert and Zener's correlation of D_0 and Q is supported by the present work; the basic qualitative prediction of Lazarus' screening theory is borne out by the present results, although the extent of the detailed agreement is not clear at this time. The experimental data yielded unexpectedly large diffusion coefficients at low temperatures in some cases and several possible causes are considered. Finally, a new experimental method is described for determining diffusion coefficients with tracers emitting only very low-energy particles.

539.217

846. DIFFUSION ACROSS A SEMICONDUCTOR–VAPOUR INTERFACE. R.Bullough, R.C.Newman and J.Wakefield.
Proc. Phys. Soc., Vol. 72, Pt 3, 369-79 (Sept., 1958).

General boundary conditions associated with diffusion across a solid–vapour interface are considered in detail and the diffusion equation is solved subject to these boundary conditions. Analytic solutions are derived for : (a) diffusion outwards of an impurity into a finite volume with or without simultaneous pumping; (b) diffusion inwards from a limited source of impurity, initially in the vapour phase, in a closed system. These results are discussed with reference to the diffusion of Group III and V elements across germanium and silicon surfaces.

539.217

847. CORRELATION AND THE ISOTOPE EFFECT FOR DIFFUSION IN CRYSTALLINE SOLIDS. A.H.Schoen.
Phys. Rev. Letters, Vol. 1, No. 4, 138-40 (Aug. 15, 1958).

It is suggested that the dependance of the diffusion coefficient on the isotopic mass of the diffusant is a function of the correlation between the directions of consecutive jumps of a diffusing atom. Isotope effect measurements should therefore be useful in deciding among possible diffusion mechanisms. Results are given and discussed for Cd^{109} and Cd^{115} diffusion in Ag and Cu. F.Ansbacher

539.217

848. DIFFUSION THROUGH BOUNDARIES IN THE SYSTEM PLASTICIZER–POLYVINYLCHLORIDE.
K.Heine, K.H.Hellwege and W.Knappe.
Z. angew. Phys., Vol. 10, No. 4, 162-6 (April, 1958). In German.

A diffusion of plasticizer takes place when two specimens of polyvinylchloride of different plasticizer content are brought into contact. This was confirmed by measuring the dependence of refractive index upon time and temperature, using mixtures of an emulsion polymer with anything between 35 and 75 weight percent of diethylhexylphthalate. The authors conclude from their results that the concentration of plasticizer at the surface of a specimen in a vacuum should not be assumed to be zero. R.Schnurmann

539.217 : 539.219

849. DIFFUSION AND SOLUBILITY OF SILVER IN GERMANIUM. A.A.Bugaĭ, V.E.Kosenko and E.G.Miselyuk.
Zh. tekh. Fiz., Vol. 27, No. 8, 1671-5 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1553-7 (Aug., 1957).

The solubility and diffusion of silver in germanium were studied by the radioactive tracer method. The results obtained are compared with the interstitial diffusion theory of Wert and Zener.

539.217.5

850. MASS SPECTROMETER MEASUREMENTS OF THE DIFFUSION COEFFICIENT OF HYDROGEN IN STEEL IN THE TEMPERATURE RANGE OF 25°-90°C.
R.C.Frank, D.E.Swets and D.L.Fry.
J. appl. Phys., Vol. 29, No. 6, 892-8 (June, 1958).

The diffusion coefficients for hydrogen in mild steel have been measured in the temperature range from 25° to 90°C. A mass

spectrometer was used to study the movement of hydrogen through thin steel plates. Two methods of measuring diffusion were used: the rate of approach to equilibrium when hydrogen is supplied to the plate, and the rate of outgassing when the source of hydrogen is removed. Two decidedly different sets of diffusion coefficients were obtained by the two methods. The first method gave diffusion coefficients which agree very well with values obtained by others at higher temperatures while the outgassing method, which was more reproducible, gave values considerably lower. These results are compared with those of other investigators.

539.217.5

851. RATIO OF THE DIFFUSION COEFFICIENTS FOR THE DIFFUSION OF HYDROGEN AND DEUTERIUM IN STEEL.
R.C.Frank, R.W.Lee and R.L.Williams.
J. appl. Phys., Vol. 29, No. 6, 898-900 (June, 1958).

The ratio of the diffusion coefficients for hydrogen and deuterium in steel were measured in the temperature range from 26° to 86° C. A mixture of the two gases was introduced into the steel by abrasion in a mixture of normal and heavy water. The diffusion coefficients were measured simultaneously for the two using the mass spectrometer to observe the rate of evolution of the gases from the steel. The ratio of the diffusion coefficients was found to be constant within the limits of experimental error over the entire temperature range and had a value of 1.37 ± 0.02. The ratio of the permeation rates was found to vary with the temperature. The results are compared with those of other investigators.

539.219

852. THE SOMMERFELD MODEL AND THE HEAT OF SOLUTION OF AN ALLOY. W.G.Henry.
Canad. J. Phys., Vol. 36, No. 5, 611-24 (May, 1958).

An approximately self-consistent method, using a Sommerfeld model, and incorporating an approximation to the second-order perturbation energy (Lennard-Jones 1930), is used to calculate the heat of solution of both monovalent–monovalent and monovalent–polyvalent alloy systems. The heat of solution, as given by the second-order approximation, varies directly with the square of the perturbing potential, and inversely with the mean total energy of the free electrons in the solvent. Varley's (1954) result resembles this, except that his expression varies inversely with the mean kinetic energy of the free electrons in the pure solute. The first-order approximation to the energy of the alloy system is identical, except for a change of sign, with the expression suggested by Friedel (1952, 1954) for the heat of solution. The charge accumulation about a solute site is found to vary directly with the strength of the perturbation, and inversely with the mean energy of the free electrons in the solvent. Varley obtained a comparable expression; however, his function varies inversely with the mean kinetic energy of the free electrons in the pure solute. The calculated charge accumulations in the copper–silver system, and for gold dissolved in silver, agree qualitatively with those of Arafa (1949) and Huang (1948).

539.219

853. KINETICS OF ALLOY SOLIDIFICATION. K.A.Jackson.
Canad. J. Phys., Vol. 36, No. 6, 683-91 (June, 1958).

Alloy systems are discussed in terms of the theory of interface kinetics which was developed in a previous paper (Abstr. 5044/1956). The non-equilibrium equations which are developed reduce to the thermodynamic expressions if the system is in equilibrium. Several types of phase diagram are discussed. It is shown that a phase diagram gives a reasonably good estimate of the concentrations at an interface if the system is not in equilibrium.

539.219

854. THERMALLY PRECIPITATED PHASES AND THEIR DISTRIBUTION IN AN ALUMINUM-SILICON-CADMIUM ALLOY.
R.E.Marburger and A.W.Schluchter.
J. appl. Phys., Vol. 29, No. 2, 84-8 (Feb., 1958).

X-ray and electron diffraction and electron microscopy were used to study the composition and distribution of the precipitated phases in an aluminium–4% silicon–1% cadmium alloy as a function of thermal history. Thin precipitated crystallites are detected in extraction replicas of specimens tempered about 400° F and have been identified by selected area electron diffraction as elemental silicon. The amount of silicon remaining undissolved after solution treatment at 1000° F can easily be distinguished from that precipitated upon tempering, and the amount of silicon observed to dissolve and reprecipitate after solution and tempering treatment is in agreement with reported equilibrium data. The aluminium oxide replica was found to be unstuiable for this investigation. A direct carbon replica technique, however, was found to be satisfactory. The extent of precipitation of the minor phases as a function of tempering temperature, as determined by quantitative X-ray diffraction studies, was found to correlate with a mechanical property of the alloy.

539.219 : 538.221 : 548.736.4

855. FURTHER MAGNETIC AND X-RAY DIFFRACTION STUDIES ON IRON-RICH IRON–ALUMINUM ALLOYS.
A.Taylor and R.M.Jones.
J. appl. Phys., Vol. 29, No. 3, 522-3 (March, 1958).

Lattice parameter determinations of body-centred iron-rich α-phase iron–aluminium alloys have revealed anomalies in the region of Fe_3Al which can be associated with magnetic properties and order–disorder transformations. In particular, it was discovered that by severely cold-working nonmagnetic alloys in the region of 35 atomic % Al, an extremely large increase in lattice volume is induced. This is of the order of 3% and is of a much larger order than that to be expected from dislocation theory. At the same time the alloys develop a high degree of ferromagnetism. Annealing the alloys for a few minutes at 150° to 200° causes the magnetism to disappear and restores the lattice parameter to its original value. The breadths of the main lattice lines after the anneal and the re-emergence of superlattice reflections seem to indicate that the loss of ferromagnetic properties is associated with lattice ordering and not with the removal of microstresses.

539.219

856. STUDY OF ORDER IN ANNEALED AND IRRADIATED ALPHA BRASS BY LATTICE PARAMETER MEASUREMENTS.
R.Feder, A.S.Nowick and D.B.Rosenblatt.
J. appl. Phys., Vol. 29, No. 6, 984-8 (June, 1958).

The increase in short-range order in alpha brass (25% and 30% Zn) produced by thermal treatment or neutron irradiation is accompanied by a measurable decrease in lattice parameter (up to 0.02%). The equilibrium values of the lattice parameter decrease markedly with annealing temperature in the lower range of the measurements, i.e. in the vicinity of 125° C. The activation energies calculated from the kinetics of the lattice parameter changes are 40.7 kcal/mole for the 25% Zn alloy, and 39.5 kcal/mole for the 30% Zn alloy, in agreement with results of inelastic measurements and electrical resistivity studies. From thermodynamic data it is estimated that a decrease in lattice parameter of 0.01% corresponds to an increase of about 0.05 in the Bethe short range order parameter.

539.219

857. ORDERING AND DISORDERING PROCESSES IN Cu_3Au. I.
L.R.Weisberg and S.L.Quimby.
Phys. Rev., Vol. 110, No. 2, 338-48 (April 15, 1958).

Data are reported which describe the isothermal change of Young's modulus with time in a single crystal of Cu_3Au following a sudden change in temperature below the critical temperature when a specimen is initially in various states of equilibrium long-range order. The results are compared with a modification of the kinetic theory of ordering and disordering proposed by Rothstein and Dienes. It appears that both processes proceed in two distinct but merging states, one of which is described well by the theory in each case. The other is plausibly ascribed to the growth and dissolution of isolated clusters of disordered atoms, similar to those deduced by Chipman from X-ray evidence. Phenomena observed in the immediate neighbourhood of the critical temperature occur when these clusters are sufficiently large and numerous to be contiguous.

539.219 : 538.222 : 537.311.31

858. THE γ PHASE IN URANIUM ALLOYS. R.G.Loasby.
Proc. Phys. Soc., Vol. 72, Pt 3, 425-8 (Sept., 1958).

Electrical resistivity and magnetic susceptibilities properties of two alloys based on γ-uranium are described and interpreted in terms of a theoretical structure derived from X-ray work Pfeil. The implication of the earlier work, that uranium in the γ form is characterized by only four electrons per atom (as opposed to six for the α and β forms), is supported by the present results.

539.219

859. METALLOGRAPHIC ASPECTS OF ALLOY JUNCTIONS.
A.S.Rose.
R.C.A. Rev., Vol. 19, No. 3, 423-32 (Sept., 1958).

Defects in the junction structure of large area alloy junction transistors were found to be associated with the presence of oxide films on the indium and germanium surfaces. Non-planar alloying, irregular germanium regrowth, and unwetted areas result. When very low dislocation density germanium crystal is used, these defects are largely minimized. With dislocation densities of the order of 5000 cm^{-2}, alloying following prior thermal deoxidation in a reducing atmosphere has a similar effect in eliminating these types of defect.

539.219

860. PHYSICAL PROPERTIES OF ALLOYS AND MOLECULAR CONCENTRATION. P.A.Savintsev.
Zh. tekh. Fiz., Vol. 27, No. 6, 1257-60 (1957). In Russian.

The molecular concentration, α, is defined as 1000 d/mol. wt. of the crystal. Similarly, α_1 and α_2 are defined for a binary alloy. Tables show how resistivity, heats of solution, expansion coefficient, eutectic temperature, temperature of superconducting transition, Brinell hardness, surface tensions and other properties can be correlated with $\alpha_1 + \alpha_2$, for alloys of metals and "alloys" of alkali halides. Metallurgical Abstracts

539.219 : 537.311.33

861. SOLID-STATE DISSOLUTION OF GERMANIUM BY INDIUM IN SEMICONDUCTOR DEVICES.
J.Roschen and C.G.Thornton.
J. appl. Phys., Vol. 29, No. 6, 923-8 (June, 1958).

The development of small pits or cavities was observed in germanium semiconductor devices with indium metal to germanium semiconductor contacts at temperatures below the melting point of indium. The mechanism of cavity formation is a solid-state dissolution of germanium by indium with a subsequent more rapid diffusion of germanium in the indium, limited by the solid solubility of the germanium in the indium. A small solid solution region exists at the indium-rich end of the germanium—indium constitutional diagram with a solid solubility limit of germanium in indium between 0.001% and 0.011% germanium by weight. The rate of solution of germanium in indium is anisotropic and dependent on the crystal orientation of the germanium. In surface barrier transistors the movement of the indium germanium interface can be expressed approximately by $L = (D\tau)^{\frac{1}{2}}$, where the expression for the average diffusion constant is $D(cm^2/sec) \cong 4 \times 10^{-3}$, $\exp(-20\,800/RT)$. Through the addition of germanium to indium or an indium alloy, solution cavity formation can be inhibited or eliminated.

539.24/.27

862. A GENERAL SCHEME FOR THE EXAMINATION OF PRECIPITATES AND INCLUSIONS IN STEELS.
G.R.Booker and J.Norbury.
Brit. J. appl. Phys., Vol. 9, No. 9, 361-5 (Sept., 1958).

A comprehensive scheme is described for the examination of included materials occurring in steels using the newer physical techniques. The material is isolated by extraction replicas in a form suitable for examination by optical and electron microscopy, electron and X-ray diffraction, and X-ray fluorescent and spectrographic analysis. Application of the scheme allows the precise form and identity of the included material to be determined, even when only small amounts of specimen are available. The extraction replica method enables particles up to about 50 μ and less than 0.01 μ in size to be satisfactorily isolated and retained for examination. The possibility of modification of the included material during isolation is small because only mild chemical treatments are used. The scheme has been satisfactorily applied so far to iron and alloy carbides and nitrides, and simple and mixed oxides and sulphides present in steels.

539.25 : 531.715 : 535.417

863. THREE DIMENSIONAL MICROSCOPY. S.Tolansky.
J. Electronics and Control, Vol. 4, No. 1, 63-95 (Jan., 1958).

An account is given of methods for the three-dimensional study of the microstructures of surfaces. The techniques described are (1) multiple-beam interferometry, (2), the light-profile microscope, (3) optical shadow casting. The first method enables height features as small as 10 A to be detected. The second method can resolve small elements of about the size of a cube of side half a light-wave. The third technique is coarser and can be applied to surfaces of roughness exceeding 2μ. The techniques are illustrated by numerous applications, including studies on crystals and metals.

539.26

864. LARGE-SCALE STRUCTURE OF POLYTHENE.
B.Belbeoch and A.Guinier.
C.R. Acad. Sci. (Paris), Vol. 247, No. 3, 310-12 (July 21, 1958). In French.

X-ray diffraction maxima at 100-200 A were found to be sensitive to temperature and mechanical treatment, and to vary only slightly with molecular weight; they are ascribed to inhomogeneities in organization of material. A.R.Stokes

539.26

865. X-RAY STUDY OF FAULTS IN BODY-CENTERED CUBIC METALS. O.J.Guentert and B.E.Warren.
J. appl. Phys., Vol. 29, No. 1, 40-8 (Jan., 1958).

The effect on the X-ray diffraction pattern of deformation faults and twin faults occurring at random on the (211) planes of a b.c.c. lattice was investigated. In single crystal reflections, deformation faults produce peak shifts and peak broadening, and twin faults produce a peak asymmetry and peak broadening. For a power pattern it is necessary to average over the different components of a powder-pattern peak; the peak shifts average out to zero, and the peak asymmetries to a quantity which is generally too small to measure. Both types of fault produce a line broadening which varies strongly from one powder peak to another. The hkl dependence of the broadening is the same for the two kinds of faults, and only a combination of the two probabilities can be measured. Measurements were made on samples of cold-worked β-brass filings in different states of annealing. There were no measurable peak shifts or peak asymmetries. The ratios of the effective particle size values could be explained only if a major part of the particle size broadening is due to faulting. The results are discussed in connection with measurements on other cold-worked b.c.c. metals.

539.27 : 537.226.2

866. EXAMINATION OF THE SURFACE AND DOMAIN STRUCTURE IN CERAMIC BARIUM TITANATE.
V.J.Tennery and F.R.Anderson.
J. appl. Phys., Vol. 29, No. 5, 755-8 (May, 1958).

Polished and etched, as well as free surfaces, of barium titanate were studied by the direct carbon replica technique. Domain configurations of both the 90° and 180° type were made visible at a higher magnification than has been possible by optical methods. The behaviour of 90° domains at a grain boundary was studied and photographed. Hexagonal and square growth patterns of the free surface were observed and photographed.

539.27

867. THE MICROTOPOGRAPHY OF OXIDE FILMS ON NIOBIUM. J.V.Cathcart, J.J.Campbell and G.P.Smith.
J. Electrochem. Soc., Vol. 105, No. 8, 442-6 (Aug., 1958).

An electron microscopic study of the oxide films formed on niobium permits the apparently anomalous oxidationrate behaviour of niobium to be explained in terms of the formation of small, blister-like cracks in the oxide film. An oxidation model, based on the idea that an oxidation process which is maintained by interstitial-anion or anion-vacancy diffusion leads to the generation of stresses in the oxide film, is proposed to account for these results. The observation of similar blister-like cracks in oxide films on tantalum is also reported.

539.27

868. AN ELECTRO-POLISHING TECHNIQUE FOR THE PREPARATION OF METAL SPECIMENS FOR TRANSMISSION ELECTRON MICROSCOPY. H.M.Tomlinson.
Phil. Mag. (Eighth Ser.), Vol. 3, 867-71 (Aug., 1958).

The conditions are described under which thin metal specimens can be produced by electropolishing for examination by transmission electron microscopy. The method was applied to Mg, Co, Cu, Ni, Al, α-brass and Fe, and representative micrographs showing the arrangement and movement of the dislocations are presented. Some practical hints are given relating to the use of the transmission electron-microscope technique for the study of dislocations in metals.

539.27 : 548.574 : 535.42

LIGHT DIFFRACTING STRIATIONS IN SILICON. See Abstr. 227

539.27 : 538.222

NEUTRON DIFFRACTION STUDY OF Ho_2O_3 MAGNETIC PROPERTIES. See Abstr. 450

ELASTICITY. STRENGTH. RHEOLOGY

539.31

869. HIGHER APPROXIMATION TO RELAXATION SPECTRA FROM DYNAMIC MEASUREMENTS. H.Fujita.
J. appl. Phys., Vol. 29, No. 6, 943-6 (June, 1958).

General methods of successive approximations to calculate the relaxation spectrum from data of dynamic mechanical measurements are worked out using an inversion theorem of integral equations of the Stieltjes type. The idea underlying the methods is essentially the same as that used by Schwarzl and Staverman (Abstr. 3644/1953) in their treatment of stress relaxation data. It is shown that the delta function method of Schwarzl and Staverman and of

Leaderman (Abstr. 5044/1954) is not a unique process of successive approximations to obtain relaxation spectra from dynamic data. Conditions to obtain a series of best approximations in terms of the delta function method are discussed.

539.31

870. ANELASTICITY OF METALS. C.Zener.
Nuovo Cimento Suppl., Vol. 7, No. 2, 544-68 (1958).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.32 : 534.232

871. ANELASTICITY OF SYNTHETIC CRYSTALLINE QUARTZ AT LOW TEMPERATURES. J.C.King.
Phys. Rev., Vol. 109, No. 5, 1552-3 (March 1, 1958).
q This is a preliminary report of an examination of the anelasticity and frequency-temperature behaviour of synthetic quartz resonators, vibrating in thickness shear at low temperatures. The stress-induced relaxation absorption occurring at 50°K for a frequency of vibration of 5 Mc/s, in natural quartz is found to be three orders of magnitude larger in some samples of the synthetic quartz. The magnitude of the 50°K absorption is dependent upon the crystallographic orientation of the seed plate upon which the quartz is grown. The frequency–temperature behaviour of the resonator over the region of maximum absorption is characteristic of a stress-induced relaxation. The crystal imperfection underlying the absorption at 50°K is considered to be responsible for the apparent lowering of the rigidity modulus of synthetic quartz above the temperature region of stress relaxation. X-ray irradiation of synthetic quartz is found to produce a marked lowering of the defect concentration responsible for the 50°K relaxation loss.

539.32 : 538.221

872. ACOUSTIC RELAXATIONS IN FERRITE SINGLE CRYSTALS. D.F.Gibbons.
J. appl. Phys., Vol. 28, No. 7, 810-14 (July, 1957).
Acoustical wave attenuation measurements have shown the existence of two types of stress-induced relaxations and a transformation in the ferrites examined. A loss mechanism due to stress-induced electron migration of the type $Fe^{+++} + e \rightleftharpoons Fe^{++}$, with an activation energy of 0.03 ± 0.004 eV per electron jump, appears to be common to all ferrites containing di- and trivalent ferrous ions on the octahedral sites. A stress-induced relaxation has been demonstrated in manganese ferrite, with an activation energy of about 0.3 eV per unit process. This relaxation process is sensitive to composition and homogeneity. Finally, a transformation has been observed in manganese zinc ferrite near 10°K, the temperature depending upon composition. A similar transformation probably occurs in manganese ferrite below 1.25°K. Below the transition temperature the intensity of magnetization is found to decrease with decreasing temperature.

539.32

873. ELASTIC CONSTANTS OF STRONTIUM TITANATE ($SrTiO_3$). E.Poindexter and A.A.Giardini.
Phys. Rev., Vol. 110, No. 5, 1069 (June 1, 1958).
The elastic constants of strontium titanate ($SrTiO_3$) were measured by the compound resonator method. Oriented quartz cylinders were used as drivers to excite the sample cylinders. The measured values for the compliance constants are $s_{1111} = 3.3 \times 10^{-13}$ cm²/dyn, $s_{1122} = -0.74 \times 10^{-13}$ cm²/dyn, and $4s_{1212} = 8.4 \times 10^{-13}$ cm²/dyn. The elastic behaviour of $SrTiO_3$ is found not to be entirely analogous to that of $BaTiO_3$.

539.32 : 534.23

874. THE EFFECT OF HEAT TREATMENT ON LOW TEMPERATURE INTERNAL FRICTION MAXIMA.
T.S.Hutchison and G.J.Hutton.
Canad. J. Phys., Vol. 36, No. 1, 82-7 (Jan., 1958).
Measurements of the attenuation of sound at a frequency of 5 Mc/s were made over the temperature range from 100° to 200°K on polycrystalline high purity aluminium subjected to various thermal and mechanical treatments. With samples annealed at 520°C a maximum in the attenuation v. temperature relation was observed at 155°K. This maximum was greatly increased by small amounts of plastic deformation of the order of 1.0 to 1.5%. Aluminium initially annealed for extended periods at temperatures much closer to the melting point shows, however, either no increase in the attenuation maximum at 155°K or, in extreme cases, no maximum in this region at all, after plastic deformation of the same order as before. It is believed that this indicates a dependence of the deformation-induced maximum on the distribution and possibly on the number of dislocations in the metal prior to deformation and on the arrangement of the dislocations after deformation.

539.32

875. EFFECT OF SUSPENSION POSITION ON APPARENT VALUES OF INTERNAL FRICTION DETERMINED BY FORSTER'S METHOD. J.B.Wachtman, Jr and W.E.Tefft.
Rev. sci. Instrum., Vol. 29, No. 6, 517-20 (June, 1958).
Values of internal friction determined by Forster's method may be in error by an order of magnitude if the effect of suspension damping is not eliminated. This damping may be reduced by placing the suspension near the nodes of the vibrating specimen, but the suspension must be sufficiently far from the nodes to provide adequate drive and pickup. The effect of suspension damping on measured values of internal friction as a function of suspension position was calculated. The calculated results were compared with experimental results and found to describe the variation correctly. The equation expressing this variation can be used to correct for suspension damping and to obtain the value of the internal friction of the specimen itself. Values as low as 5×10^{-6} were determined by this method.

539.32.08 : 534.321.9

876. OPTICAL METHODS FOR THE ULTRASONIC DETERMINATION OF THE ELASTIC CONSTANTS OF SAPPHIRE.
W.G.Mayer and E.A.Hiedemann.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 756-60 (Aug., 1958).
Three optical methods, formerly only used for isotropic media, are applied to find the ultrasonic velocities in sapphire. From the results the elastic constants are calculated for this crystal. The elastic moduli are determined from measurements of ultrasonic velocities in different crystallographic directions, and Young's modulus is plotted as function of these directions.

539.374

877. DENSITY AND HARDNESS CHANGES PRODUCED BY PLASTIC DEFORMATION IN KCl CRYSTALS.
W.H.Vaughan, W.J.Leivo and R.Smoluchowski.
Phys. Rev., Vol. 110, No. 3, 652-7 (May 1, 1958).
A study was made of the density changes which accompany plastic deformation in compression of potassium chloride crystals and of their annealing. Also hardness changes, their annealing, and slip-line formation have been investigated. Up to about 11% deformation, the slip is predominantly simple with some admixture of double slip, and no change of density is observed. At 11% deformation, multiple slip presumably sets in accompanied by a rapid decrease of density. The rate of formation of vacancies is 3.02×10^{17} cm^{-3} per cent deformation. A comparison of this value with the results of the experiments of Ueta and Känzig (Abstr. 5086/1955) leads to the ratio of about four vacancies per electron trap. Vacancies seem to have no measurable influence on hardness which thus appears to be primarily associated with changes in the dislocation density or their configuration during plastic deformation.

539.374

878. X-RAY STUDY OF DISTORTIONS IN THE CRYSTAL LATTICE OF ALUMINIUM DEFORMED AT LIQUID-NITROGEN TEMPERATURE. S.O.Tsobkallo and B.I.Smirnov.
Zh. tekh. Fiz., Vol. 27, No. 8, 1912-14 (1957). In Russian.
Hardness, (H_B), integrated X-ray line intensity (I), and broadening of the X-ray reflections (β), were measured on Al specimens deformed in compression, the degree of deformation varying from 0 to 67% at room temperature and from 0 to 45% at −196°C. From β, the size L of the crystallites formed within the grains during deformation and the degree of lattice distortion $\delta d/d$ were calculated. It was shown that: Al work-hardens more rapidly at −196°C than at room temperature; there is a close connection between H_B and I; variation of H_B is not reflected in the values of β, L, and $\delta d/d$. Metallurgical Abstracts

539.4 : 548.5

879. GROWTH AND PROPERTIES OF "WHISKERS".
S.S.Brenner.
Science, Vol. 128, 569-75 (Sept. 12, 1958).
A review of growth and mechanical strength of crystal "whiskers". 69 references.

539.4.016.3 : 539.21

880. ISOTHERMAL ANNEALING BELOW 60°K OF DEUTERON IRRADIATED NOBLE METALS.
G.D.Magnuson, W.Palmer and J.S.Koehler.
Phys. Rev., Vol. 109, No. 6, 1990-2002 (March 15, 1958).
Foils of 99.999% pure copper, 99.999% pure silver, and a copper alloy containing 3.78 atomic per cent nickel were irradiated near liquid-helium temperature with 10.7 MeV deuterons. Annealing up to 60°K was performed in a series of isothermal steps. During each

anneal the decrease of the radiation-induced resistivity increment with time was observed. Resistivity distribution curves, obtained by assuming that recovery processes with a continuum of activation energies are present, show several small peaks followed by a large peak. The maxima occur at 0.048, 0.080, 0.091, and 0.113 eV in copper and at 0.045, 0,058, and 0.079 eV in silver. The frequency factors for both metals were found to lie between 7.2×10^{10} and 3.9 ± 10^{12} sec^{-1}. Alloying served to broaden the energy distribution of the recovery processes. Changes in the Debye characteristic temperature of $-(15 \pm 1)^{\circ}K$ and $-(10 \pm 1)^{\circ}K$ were also observed in copper and silver, respectively. Annealing of these changes was about 80% complete at $50^{\circ}K$. The dominant mechanism in the low-temperature recovery is believed to be the annihilation of Frenkel pairs, with the interstitials as the mobile defects. A trapping model is proposed to explain why all the resistivity increment does not anneal out once interstitials begin to move.

539.42 : 539.216

881. STATISTICS AND TIME DEPENDENCE OF MECHANICAL BREAKDOWN IN FIBERS. B.D.Coleman.
J. appl. Phys., Vol. 29, No. 6, 968-83 (June, 1958).

A new phenomenological approach to quantitative discussions of the statistics and time dependence of mechanical breakdown is presented. The theory permits the prediction of relationships between the lifetime distributions to be observed for fibres under different loading histories: dead loads, loads proportional to time, and periodic loads. It also permits the calculation of relationships between the strength of separated individual filaments and the strength of bundles of filaments. The present formalation of the theory is more general than the author's previous work on this subject (Abstr. 6460-1/1958) in that the fibres considered here can "remember" their past history as far as breakdown is concerned. It is shown that in the case of periodic loadings, depending on the choice of certain arbitrary functions, the theory can be used to discuss either time-dependent fatigue or cycle-dependent fatigue. The relationships between the present approach and the static models used in classical theories of tensile strength distributions for single filaments and bundles are discussed.

539.42 : 539.216

882. TIME DEPENDENCE OF MECHANICAL BREAKDOWN IN BUNDLES OF FIBERS. IV. INFINITE IDEAL BUNDLE UNDER OSCILLATING LOADS. B.D.Coleman and D.W.Marquardt.
J. appl. Phys., Vol. 29, No. 7, 1091-9 (July, 1958).

For previous work see Abstr. 6460-1, 1958. The theory of breaking kinetics is used to calculate the behaviour of infinite ideal bundles under loads that are periodic functions of time. It is assumed throughout that the bundles are composed of filaments which have been randomly selected from a first-order ensemble. It is shown that the problem of calculating the lifetime of such a bundle can be reduced to one of finding the singular point in an unstable nonlinear first-order differential equation. Some general mathematical theorems are stated which help to locate the singular point in the differential equation when the ratio of the lifetime of the bundle to the period of the loading history is large. The general theory is applied to calculations of lifetimes of bundles for several specific loading histories. Detailed numerical results are reported for the special case of a sinusoidal loading history. Comparisons are made between the breakdown behaviour of separate filaments and infinite bundles of filaments.

539.433

883. MODULUS OF RUPTURE OF ZXT 45 ADP CRYSTALS. B.J.Faraday and D.J.G.Gregan.
J. appl. Phys., Vol. 29, No. 7, 1099-102 (July, 1958).

The modulus (bending strength) was determined by the three-point loading method. These measurements were performed with the aid of a breaking apparatus designed for the application of a constant loading rate commencing with the specimen in a zero-load condition. The measured values of the modulus of rupture of 245-480 kg/cm^2, with a mean of 340 kg/cm^2, agree closely with figures previously reported for ADP crystals of arbitrary orientation. No significant variation of the modulus was observed for different crystal-width to length ratios.

539.434

884. THE THEORY OF CREEP OF VISCO-PLASTO-ELASTOMER. Y.Sawaragi and H.Tokumaru.
Mem. Fac. Engng Kyoto Univ., Vol. 20, Pt 2, 117-29 (April, 1958).

539.58

885. COMPRESSION AND DENSITIES OF FOUR SOLIDIFIED HYDROCARBONS AND CARBON TETRAFLUORIDE AT $77^{\circ}K$. J.W.Stewart and R.I.La Rock.
J. chem. Phys., Vol. 28, No. 3, 425-7 (March, 1958).

The piston displacement method of Bridgman was used to measure the volume changes and compressibilities of solid ethane, ethylene, propane, propylene, and carbon tetrafluoride from 0 to 20 000 kg/cm^2 at $77^{\circ}K$. The only polymorphic phase change observed is a first-order transition at $P = 180 \pm 80$ kg/cm^2 at 77° in CF_4. The densities of these solidified gases at 77° was measured at atmospheric pressure by direct condensation into a volumetric flask. The accompanying pressure drop in a storage tank of known volume is observed.

539.58

886. ON THE COMPRESSIBILITIES OF SIMPLE METALS. W.G.McMillan and A.L.Latter.
J. chem. Phys., Vol. 29, No. 1, 15-17 (July, 1958).

An isothermal equation of state is derived from the Coulomb virial theorem for "simple" metals consisting of impeturbable (i.e., invariant) kernels embedded in a uniform sea of valence (e.g., s) electrons. Comparison with experiment at room temperature gives good agreement for the alkali and alkaline earth metals, but is understandably erratic for other groups. The compressibility is simply related to the heat of formation of the normal gaseous ion kernel.

539.62

887. THE COEFFICIENTS OF FRICTION AND WEAR. P.Sen.
Nuovo Cimento, Vol. 9, No. 4, 721-30 (Aug. 16, 1958).

The combination of the Savage surface energy and the Bowden and Tabor junction formation mechanisms of production of frictional energy is suggested. The physical description of the experiments is sufficiently simplified and represented by a stable state which envelopes the whole field of friction. This leads to a qualitative and satisfactory agreement with the observed results for the values of coefficients of friction between solid surfaces, between solid surfaces with thin liquid or solid soft metal films, for wear, and for the correlation between friction and wear. The coefficient of wear is defined analogously to the coefficient of friction.

539.621

888. THE EFFECTIVE COEFFICIENT OF FRICTION FOR STRINGS TRAVERSING CYLINDERS TRANSVERSELY AND SLANTWISE. C.Mack and C.Rubenstein.
Brit. J. appl. Phys., Vol. 9, No. 6, 247-9 (June, 1958).

A formula is given for the effective coefficient of friction in terms of the constants of the power law of friction, the angle of wrap, and the on-going tension. A table, which enables this coefficient of friction to be computed quickly and simply, is also given. Some experimental evidence for the accuracy of the formula for the slantwise case is described, while references to the experimental evidence in the transverse case are given.

539.621

889. SOME ASPECTS OF THE THERMAL DESORPTION OF A BOUNDARY LUBRICANT. E.P.Kingsbury.
J. appl. Phys., Vol. 29, No. 6, 888-91 (June, 1958).

An expression is developed relating friction coefficient in a boundary lubricated sliding system to temperature, heat of adsorption, and sliding velocity. Frictional and wear phenomena are shown to be double exponential functions of temperature and single exponential functions of sliding velocity. Experimental confirmation is obtained and a simple method is indicated for measuring the heat of adsorption as a function of temperature.

539.621

890. FRICTION COEFFICIENTS OF GRAPHITE OVER THE TEMPERATURE INTERVAL $25^{\circ}C$ TO $2450^{\circ}C$. A.R.Driesner and P.Wagner.
J. appl. Phys., Vol. 29, No. 6, 901-3 (June, 1958).

Measurements were made of the coefficients of friction for graphite and some graphite-based materials which are of interest for nuclear reactor application. Static and kinetic friction coefficients were measured as a function of surface conditioning and temperature up to a maximum temperature of $2450^{\circ}C$. In addition, the effects of force, stress, anisotropy, refractory coating, and uranium loading were studied. The most significant effect was found to be caused by the conditioning of the contact surfaces by polishing action, and this was more pronounced in the static than the kinetic friction coefficient. The friction coefficients increase with temperature. Other effects studied had negligible influence.

PHYSICAL CHEMISTRY

PHASE EQUILIBRIUM. CHEMICAL REACTIONS

541.12

891. FREE-RADICAL STABILIZATION IN CONDENSED PHASES. S.Golden.
J. chem. Phys., Vol. 29, No. 1, 61-71 (July, 1958).

The formation of stabilized free-radical mixtures by the low-temperature condensation of gases containing such species is considered. A primary concern is the amount of free-radicals resulting from such a process. The over-all process of formation of condensed phase stabilized free-radical mixtures involves the original means of their production as gases, the recombination of free-radicals as the gaseous mixtures are transported to the seat of condensation, and the recombination which occurs in the immediate vicinity of and within the condensed phase which is formed. For the present purpose only the latter aspect is considered in any detail, the effects of production and prior recombination being summarized in a stated composition for the condensing gas. For simplicity, only mixtures consisting of a single species of atomic free-radicals, diatomic molecules which may be formed from their recombination, and inert atomic species are treated. The basis for stabilization is taken to be isolation. Thus, those condensed phase mixtures are regarded as stable which do not permit free radicals to come in contact with one another. It is assumed, therefore, that condensation occurs at a temperature sufficiently low to render the effect of diffusion negligible. Such recombination which does occur is presumed to do so as a result of the juxtaposition of the atomic free radicals. Several models of the stabilization process are considered from a statistical viewpoint. In each instance no explicit reference is made to the kinetics of the recombination process. The effects of coordination number, surface condensation v. bulk condensation, condensation coefficient and clustering are treated. In each of the models the dependence of the condensed phase composition upon the gas phase composition and the statistical properties of the constituents is determined.

541.123.5

892. HYDROGEN→DEUTERIUM EXCHANGE REACTION IN α KERATIN. R.D.B.Fraser and T.P.MacRae.
J. chem. Phys., Vol. 28, No. 6, 1120-5 (June, 1958).

A quantitative study of the reaction by means of infrared spectra showed that after 50 hr at 30°C about 30% of the peptide linkages had not reacted. Observations between 50 and 1000 hr failed to detect any further reaction but elevation of pD or temperature caused additional exchange. Evidence is presented which suggests that the unreactive peptide linkages occur in the organized regions of the structure (microfibrils) and that complete exchange of the replaceable hydrogen atoms in the sidechains takes place.

541.124 : 533.7

893. DEGREE OF ADVANCEMENT IN REACTIVE GAS MIXTURES. R.L.Potter.
J. chem. Phys., Vol. 28, No. 5, 893-4 (May, 1958).

The degree of advancement in reactive gas mixtures is discussed and it is shown how derivatives of these quantities with respect to temperature and pressure can be obtained in terms of the state variables at the given state point. It is shown how such derivatives can be used in hydrodynamic problems such as computing the shifting equilibrium sound velocity.

541.124

894. STATISTICAL COMPUTATION OF REACTION PROBABILITIES. F.T.Wall, L.A.Hiller, Jr and J.Mazur.
J. chem. Phys., Vol. 29, No. 2, 255-63 (Aug., 1958).

Calculations were carried out on a high-speed electronic digital computer to determine statistically the transition probability for a simple chemical reaction. Using the London–Eyring–Polanyi form for the potential energy of the colinear system, $H + H_2$, the classical equations of motion were solved for the system under a great variety of conditions. Collisions of a hydrogen atom and a hydrogen molecule, with and without initial molecular vibration, were studied as a function of the total kinetic energy. By carrying out numerous calculations for a sufficiently large number of different initial conditi an average behaviour of the system was obtained, which provides a sat factory approximation to the quantum mechanical average. It was found that the reaction probability was greatest when the energy wa just slightly above the activation energy. Moreover, it was observ that, if the molecule was initially vibrating, only a part of the ener of vibration was available for reducing the kinetic energy of trans- lation required for activation. It was also found that the conversio of energy between vibration and translation was relatively improba

541.124 : 539.

895. THE STUDY OF CHEMICAL EXCHANGE REACTIONS BY NUCLEAR MAGNETIC RESONANCE. S.Meiboom.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1194-6 (1957).

Presented at the Summer School of the Italian Physical Society Varenna, July-August 1956.

541.124 : 532.

CHEMICAL SURFACE REACTIONS IN HYDRODYNAMIC FLO
See Abstr. 88

541.124 : 537.56

MASS SPECTROMETRIC STUDY OF NORMAL OXYGEN AND OXYGEN SUBJECTED TO ELECTRICAL DISCHARGE.
See Abstr. 363

541.12

896. EXCHANGE OF RADIOCOBALT BETWEEN THE HEXAMMINES OF COBALT (II) AND COBALT (III) IN LIQUID AMMONIA. J.J.Grossman and C.S.Garner.
J. chem. Phys., Vol. 28, No. 2, 268-70 (Feb., 1958).

Exchange of radiocobalt between $Co(NH_3)_6^{+2}$ and $Co(NH_3)_6^{+3}$ nitrates in liquid ammonia was studied at 25° and 45°C. Reactants were separated by distilling off the solvent ammonia and extracting the Co(II) as the thiocyanate complex into a mixture of ether and isoamyl alcohol. Runs were not accurately reproducible, probably because of catalytic effects from traces of oxygen in the system. Rate constants, calculated for an assumed bimolecular rate law, ar 6×10^{-5} and 7×10^{-4} l.mole^{-1} sec^{-1} at 25° and 45°C, respectively. The rate in liquid ammonia is compared with published rates in aqueous ammonia solution and with the rate of exchange of labelled NH_3 between solvent liquid ammonia and ligand ammonia in $Co(NH_3)_6^{+3}$.

541.126 : 536.4

897. GASEOUS DETONATIONS. X. STUDY OF REACTION ZONES. J.P.Chesick and G.B.Kistiakowsky.
J. chem. Phys., Vol. 28, No. 5, 956-61 (May, 1958).

For Pt IX see Abstr. 2767 (1957). The resolution time of the apparatus for rapid measurements of gas densities in shock and detonation waves by the absorption of X-rays was evaluated by studies of shock waves and found to be largely determined by the split width. The rotational relaxation of N_2, O_2, H_2, and CH_4 in mixtures with xenon and the vibrational relaxation of O_2, H_2, and CH_4 were too fast for observation. The dissociation rate constants were determined for hydrogen: $k_D = 2.5$ and 4.2×10^{-16} cm^3/sec at 2850 (?) and 3250°K, and for oxygen: $k_D = 2.3$ and 6.8×10^{-16} cm^3/s at 3100 and 3500°K. The initial (shock front) densities in $2H_2 + O_2 + \frac{1}{2}Xe$ detonating mixtures were found to be consistent with calculations based on full rotational but no vibrational relaxation, when it was assumed that the rates of exothermic reactions rise to a maximum within less than one μsec and then decrease somewhat faster than in a second-order reaction. The pre-exposu of the cold gases to X-rays for a few seconds results in faster initial reaction rates, while a pre-exposure of only a few milliseconds has no measurable effect. No effect of pre-exposure on the rates after about 50% completion of the reaction is evident. These findings indicate a highly branched mechanism of chain carrier generation. The effects of total pressure and gas composition on the duration of the reaction zone were investigated with several mixtures. Substitution of deuterium for hydrogen reduces the rate by about 30%. The retarding effect of water vapour on the rate of the hydrogen–oxygen reaction is not pronounced.

541.126

898. SOME PRECURSORS PRODUCED IN THE ELECTRODELESS DISCHARGE SYNTHESIS OF B_2Cl_4.
R.T.Holzmann and W.F.Morris.
J. chem. Phys., Vol. 29, No. 3, 677 (Sept., 1958).

The spectrum shows only bands of BCl and lines of B and Cl.

A.G.Gaydon

541.126

899. ON THE KINETICS OF THE DECOMPOSITION OF WÜSTITE BELOW 350°C. F.Halla and H.Nowotny.
Naturwissenschaften, Vol. 45, No. 16, 384 (1958). In German.

A few experimental data are recorded to show that a diffusion process is the rate determining factor in the decomposition of wüstite (an oxide of iron).

R.Schnurmann

541.127

900. KINETIC STUDIES OF HYDROXYL RADICALS IN SHOCK WAVES. I. THE DECOMPOSITION OF WATER BETWEEN 2400° AND 3200°K. S.H.Bauer, G.L.Schott and R.E.Duff.
J. chem. Phys., Vol. 28, No. 6, 1089-96 (June, 1958).

The decomposition of water vapour was studied at temperatures between 2400° and 3200°K generated in plane shock waves by following changes in the concentration of OH with time. Specific radiation absorbimetry permits these measurements to be made with microsecond resolution. The source of OH radiation used was a flash lamp containing water vapour. Measurements were made on the gas behind reflected shock waves in argon at initial pressures near 50 mm Hg and containing the reactant, H_2O, vapour, in amounts of the order of 1 mole %. The shock tube and associated electronic and optical equipment are described. Problems of purity, chemical analysis, and reduction of data are discussed. Absorption by OH was calibrated with the equilibrium mixtures resulting from the decomposition of H_2O and from the reaction of H_2 and O_2. The rate of formation of OH from H_2O is proportional to the H_2O concentration and nearly independent of the argon pressure. The effective activation energy is about 50 kcal/mole. Addition of 2% O_2 to the mixture approximately doubles the rate of OH formation and preserves the 50 kcal activation energy. Addition of 2% H_2 decreases the rate and increases the activation energy to about 80 kcal/mole. Possible reaction mechanisms are considered. The initial rate of appearance of OH cannot be interpreted in terms of the simple dissociation of H_2O into H and OH, and it seems necessary to consider a relatively low-energy path involving H_2O_2 or the HO_2 radical as an intermediate.

541.127

901. KINETICS OF THE HIGH-TEMPERATURE HETEROGENEOUS REACTION OF CHLORINE AND NICKEL BETWEEN 1200 AND 1700°K. J.D.McKinley,Jr and K.E.Shuler.
J. chem. Phys., Vol. 28, No. 6, 1207-12 (June, 1958).

The kinetics of the reaction of gaseous chlorine with metallic nickel was investigated in a constant pressure flow system in the temperature range from 1200° to 1700°K, and at chlorine pressures between 0.08 and 0.4 mm Hg. Nickel chloride produced in the overall reaction, $Ni_{(s)} + Cl_{2(g)} \rightarrow NiCl_{2(g)}$, is highly volatile at these temperatures, and the reaction thus takes place on the exposed metal surface. The process whereby nickel is removed from the surface is first order in chlorine pressure, very rapid with a collision efficiency between 0.5 and 0.2, and is temperature independent, i.e. $E_{act} < 2$ kcal. The rate constant for the removal of nickel is found to be 1.85×10^3 cm sec^{-1}, the units corresponding to moles of nickel per cm^2 of surface per unit density (M/cm^3) of chlorine. An experimental technique employing time lapse photography is described which is particularly well suited to the study of the kinetics of high temperature surface reactions with voltatile reaction products.

541.127

902. REACTIONS OF GASEOUS MOLECULE IONS WITH GASEOUS MOLECULES. IV. EXPERIMENTAL METHOD AND RESULTS. D.P.Stevenson and D.O.Schissler.
J. chem. Phys., Vol. 29, No. 2, 282-94 (Aug., 1958).

For previous work, see Abstr. 5471 (1956). A detailed description of quantitative studies of certain secondary reactions involving simple molecules and ions that occur in the ion source of a mass spectrometer. It is found that the phenomenological reaction cross-section for reactions of the type

$$P^+ + R \rightarrow S^+ + \ldots$$

are independent of the temperature of the gas in the ion source, and vary inversely with the square root of the product of the ion repeller field strength and the reduced mass of the reactant ion-reactant molecule pair. For the reactant ion (P^+) a rare gas, hydrogen, nitrogen, or carbon monoxide and the resultant molecule (R) hydrogen, the cross-sections for formation of the secondary ion, $S^+ = PH^+$, are found to be one or two orders of magnitude greater than the ordinary, kinetic collision cross-section for similar atoms and molecules.

541.127

903. REACTIONS OF GASEOUS MOLECULE IONS WITH GASEOUS MOLECULES. V. THEORY.
G.Gioumousis and D.P.Stevenson.
J. chem. Phys., Vol. 29, No. 2, 294-9 (Aug., 1958).

Ion-molecule reactions of the sort observed as secondary reactions in mass spectrometers are treated by the methods of the modern kinetic theory, that is, the rate of reaction is expressed in terms of the velocity distribution functions of the reactants and the cross-section for the reaction. The cross-section, which is calculated by means of the properties of the classical collision orbits, is found to have an inverse square root dependence on energy. The ion distribution function, which is far from Maxwellian, is found by means of an explicit solution of the Boltzmann equation. A simple relation is given which relates the mass spectrometric data to the specific rate of the same reaction under thermal conditions. For the simpler molecules, this rate may be calculated completely a priori, with excellent agreement with experiment.

541.128 : 539.2

904. IMPERFECTION DEPENDENCE OF THE CATALYTIC DECOMPOSITION OF H_2O_2 ON Al_2O_3. R.N.Tucker and P.Gibbs.
J. appl. Phys., Vol. 29, No. 9, 1374-5 (Sept., 1958).

The decomposition occurs almost exclusively at the inside radius of curvature in the deformed, contaminated crystals. An explanation is suggested based on local variations in the electronic energy band structure at the termini of edge dislocations.

W.Good

ELECTROCHEMISTRY

541.135 : 532.71

905. IRREVERSIBLE ELECTROCHEMICAL PROCESSES OF MEMBRANES. Y.Kobatake.
J. chem. Phys., Vol. 28, No. 1, 146-53 (Jan., 1958).

Theoretical equations of membrane potentials and of the permeation rates of ions through membranes are derived from the entropy production in the membranes. The entropy production is calculated by means of the irreversible thermodynamics of continuous systems based on hydrodynamics. The calculation is carried out under the assumptions that the membrane has a porous mosaic structure and that the ionic concentration in the membrane capillaries ought to be determined by means of the Poisson–Boltzmann equation, and also that there is no pressure difference between two sides of the membrane. The equation of the membrane potential obtained agrees with that derived from the Eyring theory of rate processes, but the former is more rigorous than the latter. The experimental data were found to be in good agreement with the theory. Furthermore, a new equation for the permeability of ions was derived by the same procedure.

541.135 : 532.71

906. IRREVERSIBLE ELECTROCHEMICAL PROCESSES IN MEMBRANES. II. EFFECTS OF SOLVENT FLOW. Y.Kobatake.
J. chem. Phys., Vol. 28, No. 3, 442-8 (March, 1958).

The correlation of the osmotic flow of the electrolyte solution with the membrane potential and the ionic permeability is discussed from the standpoint of the irreversible thermodynamics of continuous systems. The entropy production in the membrane having a porous structure is evaluated by means of hydrodynamical calculation taking into account the pressure, concentration, and electric potential gradient under the assumption that the ionic concentration can be determined by the Debye–Hückel approximation even in the membrane capillaries. From this entropy production a new equation for the volume flow is derived which enables one to give a reasonable explanation of the "abnormal osmosis". The equations for the membrane potential and for the ionic permeability derived similarly from the entropy production contain the additional terms due to the solvent flow in comparison with the theoretical ones given in Pt I. The new equation for the membrane potential is found to be more satisfactory than the previous one.

541.135

907. DETERMINATION OF THE FARADAIC IMPEDANCE AT SOLID ELECTRODES AND THE ELECTRODEPOSITION OF COPPER. J.O'M.Bockris and B.E.Conway.
J. chem. Phys., Vol. 28, No. 4, 707-16 (April, 1958).

The techniques of pre-electrolytic purification of the solution and the maintenance of electrodes in glass sheaths until after immersion in the purified electrolytic solution are applied for the determination of the properties of the a.c. impedance at the copper–solution interface. Measurements of double layer capacity and resistance at copper interfaces in H_2SO_4 and in $CuSO_4$ solution over a considerable potential range were made at frequencies from 10 to 2000 c/s. Significant results can only be obtained with careful elimination of screening and unsymmetry effects in the cell, and by use of spherical electrodes. The double layer impedance varies with frequency in potential regions where trivial causes such as the dissolution of Cu are not effective. The limiting double layer capacity at high frequency is about 70 μf per apparent cm^2 of the surface. Pre-electrolytic purification led to an apparent halving of the transfer coefficient and a considerable increase in exchange current density. The experimentally evaluated coefficients $\partial R_{di}/\partial\omega^{-1/2}$ (where R_{di} is the diffusional resistance) are about double those theoretically evaluated on the assumption that the true area of the electrode is equal to the apparent area. The values of the experimental coefficients $\partial R_{di}/\partial\omega^{-1/2}$ and $\partial 1/\omega C_{di}/\partial\omega^{-1/2}$ (where C_{di} is the diffusional capacitance) agree well. $\partial \ln i_o/\partial \ln a_{Cu^{++}} = 0.75$ when i_o is the exchange current density. The variation of the double layer capacity with frequency is due to dielectric loss in the water molecules in the double layer. Application of the theory of dielectric loss taking into account the distribution of adsorption energies among the water molecules shows that the observed resistance and capacitance of the double layer in certain Hg-solution and Cu-solution systems can be reproduced with the assumption of relaxation times of about 10^{-8} and 10^{-7} sec, respectively. The effect is small on Hg, but much larger on solid metals where the heat of adsorption of water is greater than on Hg. The resistance and capacitance of the double layer on solid metals is intrinsically frequency dependent and this fact (and the existence of a significant double layer resistance) must be taken into account in the evaluation of Faradaic impedance. If the intrinsic frequency dependence of the double layer is taken into account, the Faradaic resistance and the diffusional capacitance behave theoretically; if a frequency-independent double layer impedance is utilized, irrational values of the Faradaic impedance and reaction resistance are obtained. Diffusion occurs to only about one-fifth of the true surface area.

541.135.4

908. ION EXCHANGE KINETICS. A NONLINEAR DIFFUSION PROBLEM. F.Helfferich and M.S.Plesset.
J. chem. Phys., Vol. 28, No. 3, 418-24 (March, 1958).

Ideal limiting laws are calculated for the kinetics of particle diffusion controlled ion exchange processes involving ions of different mobilities between spherical ion exchanger beads of uniform size and a well-stirred solution. The calculations are based on the nonlinear Nernst–Planck equations of ionic motion, which take into account the effect of the electric forces (diffusion potential) within the system. Numerical results for counter ions of equal valence and six different mobility ratios are presented. They were obtained by use of a digital computer. This approach contains the well-known solution to the corresponding linear problem as a limiting case. An explicit empirical formula approximating the numerical results is given.

541.135.5 : 541.15

909. THE EFFECT OF GAMMA IRRADIATION ON THE POTENTIAL BEHAVIOR OF PLATINUM AND STAINLESS STEEL ELECTRODES. W.E.Clark.
J. Electrochem. Soc., Vol. 105, No. 8, 483-5 (Aug., 1958).

All measurements on the electrodes were carried out in 0.1 N H_2SO_4 at 85°C, and under atmospheres of air, nitrogen, and hydrogen. Imposition of the radiation causes rapid debasement of the metal of the electrode indicated by the (rapid) change of potential. Under an atmosphere of air this is followed by slow ennoblement which does not occur under hydrogen or nitrogen. Removal of the irradiation results in rapid ennoblement. The potential of one sample of steel was debased to a value indicating active corrosion (evolution of hydrogen), the steel eventually recovering its noble potential while still under irradiation. The results are discussed in the light of the reactions of importance in the radiolysis of water.

W.Good

PHOTOCHEMISTRY. RADIATION CHEMISTRY

541.15 : 532.72

910. APPLICATION OF A HIGH-SPEED ELECTRONIC COMPUTER IN DIFFUSION KINETICS. D.A.Flanders and H.Fricke.
J. chem. Phys., Vol. 28, No. 6, 1126-9 (June, 1958).

The Argonne electronic computer AVIDAC is applied in the numerical solution of $\partial n/\partial t = \nabla^2 n - k_1 n^2 - k_2 n$, which, with suitable boundary and initial conditions, represents the reaction kinetics of the one-radical model used earlier by Fricke to describe the track effect in the radiation chemistry of a solution of a single solute. The fractional number of radicals combining with solute molecules is computed in terms of two dimensionless parameters that completely define the problem. Comparison with the formulas derived by using Jaffé's approximation method shows in most cases agreement to within 10% (though in some extreme cases only to within 50% to 80%), which indicates that Jaffé's method should give useful results in developing other aspects of diffusion kinetics.

541.15

911. HYDROGEN FORMATION IN CONCENTRATED AQUEOUS SODIUM SULFATE SOLUTIONS BY COBALT-60 GAMMA-RAY RADIATION. H.A.Mahlman.
J. chem. Phys., Vol. 28, No. 6, 1256-7 (June, 1958).

A 900 curie cobalt-60 source was used in the irradiation of Na_2SO_4 solutions containing 10^{-3} M KBr. The latter was added to protect the molecular H_2 from radical attack. The solutions were degassed before irradiation and the H_2 determined by ignition with O_2 on a platinum filament. $G(H_2)$ was determined on the basis of $G(Fe^{+++}) = 15.6$ and was found to be 0.48, in good agreement with other estimations. It is concluded that bisulphate ions and sulphate ions are not effective hydrogen atom scavengers. M.Ebert

DISPERSIONS. COLLOIDS. ADSORPTION

541.182

912. AUTOMATIC ISOKINETIC SAMPLING.
J.Rosinski and A.Lieberman.
Appl. sci. Res. A, Vol. 6, No. 2-3, 92-6 (1956).

An automatic device was constructed for sampling air isokinetically. The automatic feature consists of a motor-operated by-pass valve controlled by a Wheatstone bridge. Transducers, sensitive to changes in air velocity, are the sensing elements in the bridge. Experimental results are given in which the controlled sampling velocity was shown to follow changes in wind velocity very accurately.

541.183.56

913. THERMAL RESTORATION OF OXYGENATED GERMANIUM SURFACES. A.J.Rosenberg, P.H.Robinson and H.C.Gatos.
J. appl. Phys., Vol. 29, No. 5, 771-5 (May, 1958).

Cleaved germanium surfaces, oxygenated at room temperature, were heated under high vacuum and the restoration of their oxygen-adsorbing capacity was determined. No restoration was observed at 425°C. Above 575°C, however, the oxygen-adsorbing capacity of the surfaces was completely recovered. Discharge of GeO from the surface was associated with this process. The restoration process followed first-order reaction kinetics with an activation energy of 56 kcal/mole. Concurrently with restoration a pronounced decrease in the surface area was observed. The results are discussed in terms of the kinetic and energy requirements of the system.

CHEMICAL ANALYSIS

545.822 : 535.343

914. SPECTRAL EXCITATION IN HIGH-TEMPERATURE FLAMES AS A FUNCTION OF SAMPLE FLOW.
M.R.Baker, K.Fuwa, R.E.Thiers and B.L.Vallee.
J. Opt. Soc. Amer., Vol. 48, No. 8, 576 (Aug., 1958).

In spectrochemical analysis, the strength of emission lines reaches a maximum with increasing flow of solution, and then falls because of cooling of the flame by excess solution. Theoretical and experimental results are given for Ca lines in a cyanogen flame.

A.G.Gaydon

545.824

915. X-RAY ABSORPTION MICROANALYSIS WITH FINE-FOCUS TUBES. J.V.P.Long.
J. sci. Instrum., Vol. 35, No. 9, 323-9 (Sept., 1958).

A point-focus X-ray tube was used as a source for micro-analysis by the X-ray absorption method. Transmission measurements on selected specimen areas of 2-10 μ diameter are possible, with wavelengths chosen by a crystal and a proportional counter. Comparison of the transmitted intensities at different wavelengths gives quantitative information on the mass thickness of elements present in the area examined. The ultimate mass sensitivity varies with the position of the element in the periodic table, but is usually in the range 10^{-10}-10^{-12} g for elements of $Z > 15$. The application of the method to the determination of calcium is described.

CRYSTALLOGRAPHY

548.23 : 538.221

916. ORIENTATION STUDY OF ULTRA-THIN MOLYBDENUM PERMALLOY TAPE. P.K.Koh.
J. appl. Phys., Vol. 29, No. 4, 636-57 (April, 1958). Abridged version: Ibid., No. 3, 356-8 (March).

Quantitative pole density stereograms of {111}, {220}, {200}, and {113} poles of $\frac{1}{8}$ mil molybdenum Permalloy tape were developed in order to establish its cold-rolled deformation texture and annealed textures. Cold rolling the tape induced multiple slip common to all face-centred-cubic metals and developed (110)[$\bar{3}$35] and (110)[3$\bar{3}$5] end orientations which deviate 5° about [110] from the recognized {110} ⟨112⟩ brass deformation texture. On annealing at 771°C the cold-rolled tape was found to develop (120)[001] + (210)[001] and (113)[$\bar{7}\bar{8}$5] + (113)[78$\bar{5}$] orientations as components of the annealed texture which bear in general at 35°-45° rotation orientation relationship about ⟨111⟩ with the cold-rolled end orientations. Annealing at 1160°C developed the same texture as that obtained after 771°C annealing. From the pole figures made on 927°C annealed tape, the same annealed texture prevailed whether the pole figure was made on its full $\frac{1}{8}$ mil thickness or on its central 0.00005 in. section. Hysteresis loop tracings made on the cold-rolled tape revealed an apparent direction of easy magnetization along the rolling direction. No easy magnetization direction was revealed in the rolling plane on the annealed tapes. These findings support the deductions from the corresponding pole figures.

548.3

917. THE HYDROLYSIS OF SOLID CaF_2. W.Bontinck.
Physica, Vol. 24, No. 8, 650-8 (Aug., 1958).

It was shown that water vapour is the active component for the change of the properties of CaF_2 after thermal treatment at high temperatures (1000-1200°C). The reaction consists of the diffusion of anion vacancies of oxygen ions. Hydroxyl ions are only present at the beginning of the reaction. When an equilibrium concentration of anion vacancies is formed, the reaction proceeds by coagulation of colloidal CaO particles, which precipitate principally along dislocation lines.

548.3 : 538.221

RELATION BETWEEN CRYSTALLITE ORIENTATION AND MAGNETIC PROPERTIES OF ELONGATED SINGLE-DOMAIN IRON PARTICLES. See Abstr. 436

548.5 : 532.78

918. NUCLEATION AND GROWTH IN A PHOTOSENSITIVE GLASS. R.D.Maurer.
J. appl. Phys., Vol. 29, No. 1, 1-8 (Jan., 1958).

The nucleation and growth of particles can be independently determined by simultaneous measurement of two quantities having different functional dependencies upon particle number and size. Light scattering and optical absorption are the two quantities chosen to observe the precipitation kinetics of a gold colloid. When an exposed photosensitive glass is treated at high temperatures, gold precipitates on a fixed number of sites. On the other hand, increasing the concentration of reactants causes spontaneous gold precipitation in which growth sites form continuously throughout the precipitation process. This indicates that the photosensitive reaction forms nuclei in a supersaturated solution which cannot nucleate spontaneously. In agreement with this, the experiment shows that the number of growth sites increases with exposure while the growth rate is the same for all exposures. Assuming that the particles are spheres, absolute values are derived for the initial change of particle size with time and for the number of nuclei as a function of exposure.

548.5 : 539.4

GROWTH AND PROPERTIES OF "WHISKERS". See Abstr. 879

548.523

919. GRAY TIN SINGLE CRYSTALS. A.W.Ewald and O.N.Tufte.
J. appl. Phys., Vol. 29, No. 7, 1007-9 (July, 1958).

A method of growing these crystals from a liquid amalgam is presented, together with a description of the apparatus and specification of the conditions of growth. Photographs of typical crystals ranging in size up to 2 cm and showing well developed crystallographic planes are included. Residual resistance measurements indicate a total impurity content of the order of 0.001%. The energy gap is the same as for transformed material but the low-temperature mobilities are considerably higher. Evidence that the grey-to-white transformation is of the diffusionless type is presented.

548.53 : 669.04

920. MATHEMATICAL TREATMENT OF A TYPICAL ZONE-MELTING PROCESS. G.Braun.
Philips Res. Rep., Vol. 12, No. 5, 385-414 (Oct., 1957).

Deals with a typical example of a zone-melting process, as described by Van den Boomgaard (Philips Res. Rep., Vol. 10, No. 5, 319-36, Oct., 1955). The process is used to achieve the most homogeneous distribution of a solute (which may be volatile) in an ingot. This is effected by a large number of identical steps and amounts to an extension of the procedure proposed by Pfann and Reiss. The intermediate distributions tending to the limiting one are considered in detail, as well as the number of steps necessary to arrive at such a distribution. The mathematics determine the asymptotic behaviour of the solution of a system of differential difference equations by means of a generating function.

548.57

921. CONTROL OF LINEAGE STRUCTURE IN ALUMINUM CRYSTALS GROWN FROM THE MELT. K.T.Aust and B.Chalmers.
Canad. J. Phys., Vol. 36, No. 7, 977-80 (July, 1958).

The formation of regular, continuous, straight, low-angle boundaries (striations) during freezing of a metallic crystal may be avoided by inclination of the advancing solid–liquid interface with respect to the direction of freezing.

548.57

922. GROWTH OF MAGNETIC GARNET CRYSTALS.
J.W.Nielsen.
J.appl. Phys., Vol. 29, No. 3, 390-1 (March, 1958).

Single crystals of magnetic garnets were grown from solutions of molten lead oxide, iron oxide and the oxides of yttrium, samarium, erbium or gadolinium. The crystals are grown by slowly cooling melts from 1325°C to near 900°C. A convenient composition is 52.5 mole % PbO, 44 mole % Fe_2O_3, and 3.5 mole % M_2O_3 where M is Y, Gd, Er or Sm. Crystals of yttrium-iron garnet were grown which contain gallium partially substituted for iron. The method may also be extended to the growth of nonmagnetic yttrium gallium garnets by using a melt which is 72.7 mole % PbO, 26 mole % Ga_2O_3 and 1.3 mole % Y_2O_3. Bismuth oxide can be used as a solvent for the growth of magnetic garnet crystals but the substitution of bismuth in the garnet lattice makes it less desirable than lead oxide.

548.574 : 537.311.33

923. SELECTIVE ELECTROLYTIC ETCHING OF GERMANIUM AND SILICON JUNCTION TRANSISTOR STRUCTURES.
I.A.Lesk and R.E.Gonzalez.
J. Electrochem. Soc., Vol. 105, No. 8, 469-72 (Aug., 1958).

The electrolytic dissolution of germanium and silicon was applied to the selective etching of n–p–n and p–n–p junction transistor structures. By employing the electrical properties of p–n junctions internal to the pellet as well as the electrolytic behaviour of the n- and p-type germanium or silicon, part of the emitter or collector (or both) of a transistor pellet may be etched away, leaving the rest of the pellet intact. The resulting exposure of part of the base region may be used to locate the base region and facilitate attachment of the transistor base lead.

548.574

924. ETCHING OF GERMANIUM CRYSTALS BY ION BOMBARDMENT. G.K.Wehner.
J. appl. Phys., Vol. 29, No. 2, 217-21 (Feb., 1958).

A study is made of the etch effects produced by sputtering germanium crystals and bicrystals under normal incident low-energy (100 eV) Hg^+-ion bombardment in a low pressure plasma (1 μ gas pressure). The surfaces show preferentially etched pits which readily reveal the crystal orientation. These pits become more abundant at lower target temperature and truncated at higher target temperature or at higher energy of the bombarding ions. A sequence of micrographs from the same surface area reveals that these pits cannot be correlated with the pits which are persistently developed by CP-4. A 6° tilt boundary, however, always develops into a sharply indented furrow just as was the case with a CP-4 etchant.

548.574 : 771.531

925. ETCHING STUDIES ON PHOTOGRAPHIC GRAINS.
J.F.Hamilton, L.E.Brady and F.A.Hamm.
J. appl. Phys., Vol. 29, No. 5, 800-3 (May, 1958).

The application of preferential etching techniques to the study of crystalline imperfection in photographic emulsion grains is described. Both chemical etching and halogen evolution by print-out exposure in the absence of gelatin form well-defined pits in most cases. The concentration of chemical etch pits is dependent on the solvent used but is not sensitive to concentration or etch time over the range investigated. A general increase in etching on certain faces is found after intentionally straining the grains, but the effect is not sufficiently strong to establish a one-to-one relationship between etch pits and dislocations. In both silver bromide and silver bromo-iodide grains, no evidence is found for the existence of any type of polycrystalline substructure. Experiments on pitting by print-out exposure indicate that iodide ions provide internal hole traps or recombination centres.

548.574

926. A STUDY OF ETCHING STRUCTURE ON ALUMINIUM BY TRANSMISSION ELECTRON MICROSCOPY.
R.Phillips and N.C.Welsh.
Phil. Mag. (Eighth Ser.), Vol. 3, 801-5 (Aug., 1958).

Aluminium foils thinned by acid etching were examined by transmission electron microscopy. Cellular patterns, 0.2 microns in spacing, were observed superimposed upon the normal subgrain structure of the metal. The cellular structure resembles patterns observed by other workers on replicas of chemically polished aluminium and interpreted as evidence of crystal misorientation. This communication shows that the cellular structure arises from a surface etching process and bears no relation to the distribution of dislocations in the metal. It is therefore most improbable that a further subdivision of the crystals is revealed.

548.574

927. ETCHING OF GERMANIUM AND SILICON. P.Wang.
Sylvania Technol., Vol. 11, No. 2, 50-8 (April, 1958).

In order to etch germanium and silicon, an oxidizing agent and a complexing agent are needed. By varying the etchant, the etching conditions and techniques, different surfaces can be obtained for various purposes. A simplified picture of the etching reaction is given and the etching rates of common etches are presented. Etching techniques for common germanium and silicon devices are reviewed and an attempt is made to explain the chemistry of etched germanium surfaces and their relation to device characteristics.

548.574 : 539.27 : 535.48

LIGHT DIFFRACTING STRIATIONS IN SILICON. See Abstr. 227

X-RAY CRYSTALLOGRAPHY

548.7 : 539.2

SMALL-ANGLE SCATTERING FROM EXTENDED DISLOCATIONS. See Abstr. 802

548.73/.74

X-RAY AND ELECTRON INVESTIGATION OF MATERIALS. See also the Section entitled "STRUCTURE OF SOLIDS".

548.732

928. TRANSPARENCY FACTOR FOR WEAKLY ABSORBING SAMPLES IN X-RAY DIFFRACTOMETRY. M.E.Milberg.
J. appl. Phys., Vol. 29, No. 1, 64-5 (Jan., 1958).

Equations are developed for the transparency factor applicable to the intensity of X-rays scattered from very weakly absorbing materials in the standard diffractometric technique. The expressions differ from the standard absorption correction because of the variation of effective scattering volume with angle. Both equations and illustrative curves are presented.

548.733

929. SOME DEVELOPMENTS AND APPLICATIONS OF MICROFOCUS X-RAY DIFFRACTION TECHNIQUES. A.Franks.
Brit. J. appl. Phys., Vol. 9, No. 9, 349-52 (Sept., 1958).

A low angle X-ray scattering camera, a microbeam camera and an electron gun for a microfocus X-ray tube are described. In the low angle scattering camera which can resolve a spacing of 1000 A using Cu K-radiation, the X-ray beam is totally reflected by two crossed bent glass plates, which focus the relatively intense beam on to a small spot on the film. Provision is made for accurately positioning a selected area of the specimen in the path of the beam. This facility is also provided in the microbeam camera for transmission and back reflection work. In the electron gun, focusing is facilitated by independent adjustments of the positions of the filament and grid cylinder, while the tube is in operation.

548.733

930. GEARING SYSTEM FOR A CONTINUALLY-ALIGNED TWO-CRYSTAL X-RAY SPECTROMETER.
H.P.Hanson and R.Economy.
Rev. sci. Instrum., Vol. 29, No. 5, 420-2 (May, 1958).

A spectrometer which is able to scan continuously through Bragg angles of 10°–45° is described. The appropriate angular changes of the components are effected through a planetary gear system. The unit in use is adapted to a Norelco goniometer.

548.734.82

931. RAPID X-RAY DETERMINATION OF A COMPLETE POLE FIGURE. J.B.Newkirk and L.Bruce.
J. appl. Phys., Vol. 29, No. 2, 151-7 (Feb., 1958).

The Decker, Asp and Harker technique (Abstr. 3528/1958) and the Schultz technique for obtaining pole figure X-ray data in the transmission and back-reflection regions, respectively, are shown to give sufficient data for a complete pole figure, with consistent intensity contours in a 15° annulus of overlap. An improved integrating specimen holder, based on the design of Geisler, was found to perform satisfactorily for transmission and back-reflection operation. A powder method for making all-metal sheet specimens with randomly oriented crystals is described. The use of this type of random sample for establishing background and 1X intensity levels for a corresponding textured specimen is shown to give results which are only semi-quantitative when normal filtered radiation is used.

548.735.2

932. ON THE DETERMINATION OF THE SPACE-GROUP BY THE STATISTICAL METHOD. M.S Farag.
Nuovo Cimento, Vol. 9, No. 4, 694-8 (Aug. 16, 1958).

Following A.J.C.Wilson and his collaborators, it is possible, by a study of the statistical distribution of X-ray intensities of Bragg reflections, to differentiate between centro- and non-centrosymmetric structures. This method was applied to a centred and a non-centred projection in the crystal structure of 1.3.5-triphenylbenzene. The results in both zones showed big discrepancies which could lead to an incorrect conclusion. These discrepancies are discussed in terms of the established structure which is of a layer type. The molecules are projected edgewise in the centred projection, and the electron density distribution appears in the other one, with some approximations, as if centred.

548.736.1

933. STRUCTURE OF THALLIUM AND GADOLINIUM AT LOW TEMPERATURES. C.S.Barrett.
Phys. Rev., Vol. 110, No. 5, 1071-2 (June 1, 1958).

X-ray diffraction at temperatures from 300°K to 5°K were employed to search for a low-temperature transformation in thallium that might account for the anomaly in the pressure coefficient of the superconducting transition temperature of this element. No evidence of instability of the normal close-packed hexagonal structure was obtained either after cooling or after cold work at various low temperatures. Similarly, the close-packed hexagonal structure of gadolinium was found to be stable to 5°K.

548.736.4 : 538.221

CRYSTALLOGRAPHIC STUDY OF THE SYSTEM $(NiFe_2O_4)_{1-x} + (NiMn_2O_4)_x$. See Abstr. 432

548.736.4 : 538.221 : 539.219

X-RAY DIFFRACTION STUDIES ON IRON–ALUMINIUM ALLOYS. See Abstr. 855

548.736.5 : 538.221

CRYSTALLOGRAPHIC PROPERTIES OF THE SYSTEM $LaMn_{1-x}Ni_xO_{3+\lambda}$. See Abstr. 428

548.74 : 538.221

ANTIFERROMAGNETIC STRUCTURES OF MnS_2, $MnSe_2$, AND $MnTe_2$. See Abstr. 429

GEOPHYSICS

550.38

934. DETERMINATION OF THE MAGNETIC MOMENT OF BEDS OF FERROUS ORES. D.Zidarov.
C.R. Acad. Bulg. Sci., Vol. 11, No. 2, 77-80 (March-April, 1958).
In French.

Shows that, from a knowledge of the vertical component of the magnetic potential gradient over a horizontal plane, it is possible to determine the magnetic moment of a perturbing body provided that this is uniformly magnetized. A.E.De Barr

550.38 : 532.5 : 538.3

935. THE MAGNETIC FIELD AND THE CENTRAL CORE OF THE EARTH. L.Knopoff and G.J.F.MacDonald.
Geophys. J., Vol. 1, No. 3, 216-23 (Sept., 1958).

The suggestion that the inner core of the earth is liquid and is the seat of a strong magnetic field is examined. Contrary to expectations of a magnetohydrodynamic rigidity for the inner core, it is shown that a liquid inner core with a strong magnetic field should not transmit shear waves. The absence of the phase PKJKP in seismic records is favourable to the hypothesis of a strong magnetic field in a liquid inner core. If the jump in P wave velocity at the inner core boundary is due to a magnetic field, the strength of the field must be of the order of 5×10^8 G whether the field geometry is toroidal or random. A strong toroidal field leads to an apparent ellipticity of the inner core. No such ellipticity is observed, so that if the field in the inner core is toroidal, it must be less than 5×10^5 G. A random field does not lead to an ellipticity effect and no limit can be set on the magnitude of a random field. The energy required for a magnetohydrodynamic rigidity in the inner core is excessive. The magnetic energy is equally divided between the inner and outer cores. The hypothesis of a strong magnetic field in the inner core cannot explain the observed short-period variations of the surface field.

550.38

936. REVERSALS OF THE EARTH'S MAGNETIC FIELD. D.W.Allan.
Nature (London), Vol. 182, 469-70 (Aug. 16, 1958).

Numerical integration of the equations for two disk dynamos coupled to one another shows that reversals of the current in their coils can occur under a wide range of conditions. Some implications of this result in connection with reversals of the earth's magnetic field are considered. A.E.De Barr

550.385

937. S_q-FIELD IN THE POLAR REGION ON ABSOLUTELY QUIET DAYS. T.Nagata and H.Mizuno.
J. Geomagn. Geoelect., Vol. 7, No. 3, 69-74 (Sept., 1955).

550.831 : 526.77

SEA GRAVIMETER. See Abstr. 15

550.834 : 534.2

SURFACE AMPLITUDES OF REFLECTED BODY WAVES. See Abstr. 131

550.837 : 537.226.8

DEPTH OF A SATURATED AQUIFER. THEORETICAL STUDY OF INDUCED ELECTRICAL POLARIZATION. See Abstr. 281

551.311.123

938. PHYSICS OF ICE MOVEMENT. J.W.Glen.
Nature (London), Vol. 182, 1560-2 (Dec. 6, 1958).

A report of a symposium on the "Physics of ice movement" held at Chamonix (France) during September 16-24, 1958. This symposium was organized by the Commission for Snow and Ice of the International Association for Scientific Hydrology. The proceedings (41 papers, 394 pp.) are published by Association Internationale d'Hydrologie Scientifique (61 rue des Ronces, Gentbrugge, Belgium).

ATMOSPHERE. IONOSPHERE

551.508

939. RECENT DEVELOPMENTS IN METEOROLOGICAL INSTRUMENTS AND TECHNIQUES IN INDIA. K.S.Agarwala.
Indian J. Meteorol. Geophys., Vol. 9, No. 3, 207-12 (July, 1958).

551.508.21

940. AN ELECTRONIC ACTINOMETER FOR MEASUREMENTS IN NARROW SPECTRAL RANGES. H.J.Albrecht.
Indian J. Meteorol. Geophys., Vol. 8, No. 2, 193-8 (April, 1957).

Describes the use of capacitance bolometers for the measurement of direct solar radiation. Electronic and optical design factors are given, together with constructional and operation details. Indicating methods for capacitance bolometers are discussed, with particular reference to this actinometer.

551.510.3

941. MEASUREMENT OF THE TEMPERATURE OF ATMOSPHERIC OZONE BY MEANS OF THE HUGGINS BANDS. H.Zschörner and H.K.Paetzold.
Mitt. Max Planck-Inst. Phys. Stratosphäre, No. 4, 24 pp. (1955).
In German.

Both the theoretical and experimental aspects of the problem are outlined and discussed. Since the results obtained from spectrophotometric reduction are very dependent on the optical constants of the spectrograph employed (e.g. resolving power, instrumental profile), it is essential to calibrate the instrument in the laboratory over the requisite working range of wavelengths, and spectral intensities, by photographing the Huggins spectrum of sunlight, using measured absorptions of additional O_3 maintained at a series of known temperatures. It is then possible to derive the temperature of atmospheric O_3 with a p.e. of only 1-2°C, for a path length of ~1 cm. D.R.Barber

551.510.4

942. PROTONS OUTSIDE THE EARTH'S ATMOSPHERE. O.Storey.
Ann. Geophys., Vol. 14, No. 2, 144-53 (1958).

The evidence is surveyed for the belief that hydrogen is the main ionizing constituent of the earth's atmosphere at great heights. If this view is correct, it should be possible to detect the protons by making precise measurements of the dispersion curves of whistling atmospherics observed at low latitudes.

551.510.41

943. DETERMINATION OF UPPER ATMOSPHERE SODIUM ABUNDANCE FROM D_2/D_1 MEASUREMENTS IN TWILIGHT. T.M.Donahue.
Phys. Rev. Letters, Vol. 1, No. 8, 287-8 (Oct. 15, 1958).

The theoretical intensity-ratio of the Na D-lines emitted at twilight should be ~1.75 in the absence of resonance absorption in the terrestrial atmosphere. However, recent observations (at Saskatoon) of this ratio at an effective solar depression of 7°.5, show that the observed ratio deviates greatly from the expected value,

though the scatter is high. The results are anomalous, also, in showing a very low intensity-ratio in summer when the atmospheric Na abundance is a minimum. It is here suggested that these results are, in part, a consequence of the screening effect of troposphere and ozonosphere on the Na layer at 85-90 km. Measurements of the dependence of the D_2/D_1 intensity-ratio on solar depression angle, if made from early to late twilight, should yield valuable information regarding the exact relation between Na density and altitude.

D.R.Barber

551.510.5

944. THE UPPER ATMOSPHERE.
H.S.W.Massey and R.L.F.Boyd.
London: Hutchinson (1958) 333 + xii pp.

A comprehensive account of the phenomena of the earth's atmosphere beyond an altitude of about 10 miles, covering the techniques used, the results obtained, and their interpretation. The book is mainly non-mathematical, and has no detailed references, although many of the line drawings are based on figures from original papers, the authors of which are given. There are liberal illustrations, a short general bibliography, and a fairly detailed index. Relevant aspects of general physics are summarized in the opening chapter, and following a synopsis of the main properties of the atmosphere, the chief probing techniques are discussed in detail: balloons, rockets, sound, light, and radio waves, with a penultimate chapter on artificial satellites. In the remaining chapters there are descriptions of specific phenomena, which include absorption of solar radiation; ozone; ionosphere; polar aurora; airglow; lunar and solar atmospheric tides; dynamo currents in the atmosphere; solar, magnetic and ionospheric disturbances; meteors; cosmic rays. The final chapter suggests the lines along which future development is likely to progress, and lists some important outstanding problems.

G.M.Brown

551.510.535

945. A NEW MODEL OF THE ATMOSPHERE AND IONOSPHERE.
H.K.Kallmann.
Ann. Geophys., Vol. 14, No. 2, 140-3 (1958).

The variation of electron density with height in the atmosphere was determined theoretically, using a new model of the atmosphere as derived from rocket observations. The results compare favourably with direct rocket measurements of electron densities, but they give a somewhat different picture of the ionosphere from that deduced from simultaneous P'f recordings. G.M.Brown

551.510.535 : 537.567

946. EXPERIMENTAL PHOTODETACHMENT CROSS SECTION AND THE IONOSPHERIC DETACHMENT RATE FOR O_2^-.
S.J.Smith, D.S.Burch and L.M.Branscomb.
Ann. Geophys., Vol. 14, No. 2, 225-31 (1958).

The results of a measurement of the photo-detachment cross-section of O_2^- are described briefly. From this cross-section the photo-detachment rate for O_2^- in the ionosphere is determined to be 0.44 photo-detachments per ion per second. The negative ion to free electron ratio is estimated for the D-layer. Some implications for ionospheric physics of the shape of the cross-section are discussed.

551.510.535 : 538.3 : 532.5

947. A DYNAMO THEORY IN THE IONOSPHERE.
M.Hirono and T.Kitamura.
J. Geomagn. Geoelect., Vol. 8, No. 1, 9-23 (March, 1956).

The differential equations of the dynamo theory are solved by numerical integration, taking into account the daily variation of the anisotropic conductivity. It is shown that the observed wind velocities in the E-region satisfy the requirements of the dynamo theory. The drift of the ionization is discussed, and it is shown that at night some of the electrons in the lower F-region will descend into the E-region in the middle latitudes.

551.510.535

948. ON THE DISTURBANCE DAILY VARIATIONS AND THE LUNAR DAILY VARIATIONS IN THE F2 REGION OF THE IONOSPHERE ON THE MAGNETIC EQUATOR. H.Maeda.
J. Geomagn. Geoelect., Vol. 7, No. 3, 75-85 (Sept., 1955).

551.510.535

949. RELATIONS AMONG RADIO ABSORBING REGIONS, GEOMAGNETIC BAY-DISTURBANCES AND SLANT-Es IN AURORAL LATITUDES. S.Matsushita.
J. Geomagn. Geoelect., Vol. 8, No. 4, 156-60 (Dec., 1956).

551.510.535

950. VERTICAL IONOSPHERIC SOUNDINGS AT AHMEDABAD DURING TOTAL SOLAR ECLIPSE ON 30TH JUNE 1954.
R.G.Rastogi.
Proc. Indian Acad. Sci. A, Vol. 46, No. 6, 422-9 (Dec., 1957).

551.510.535

RADIOWAVE PROPAGATION IN THE IONOSPHERE. See also the Section entitled "ELECTROMAGNETIC WAVES AND OSCILLATIONS".

551.521.3

951. ATMOSPHERIC ABSORPTION IN THE NEAR INFRARED.
M.Lunel.
C.R. Acad. Sci. (Paris), Vol. 247, No. 4, 490-3 (July 28, 1958).
In French.

Near infrared absorption at Haute Provence is too large to be accounted for by pure molecular scatter, but can be explained as a selective absorption by water vapour combined with optical scatter from haze. D.R.Barber

551.521.3 : 551.594.5

952. RECENT WORK AT THE UNIVERSITY OF SASKATCHEWAN [AT SASKATOON AND AT CHURCHILL] ON AURORAL AND NIGHT SKY SPECTRA. D.M.Hunten.
Ann. Géophys., Vol. 14, No. 2, 167-74 (1958).

Measurements of rotational temperature of the N_2^+ band at 3914 A are consistent with the expected gradient of 6 deg/km. Spectral features observed include several bands of the N_2^+ Meinel system: (0,0), at 11 100 A and (0,1) and (1,2) near 15 000 Å. The (1,0) and (1,2) bands often have anomalously high intensity; it may be that they are excited preferentially by collision with O^+ (^2D). Hydrogen lines appears further south in the stronger auroral displays, but other predictions of the Martyn theory are not confirmed. OH bands in the airglow were observed out to 20 000 A; the intensity of the (4,2) band was measured as 175 kilorayleighs and the rotational temperature as 200°K.

551.521.326

953. AIRGLOW OBSERVATION ON BOARD THE "SOYA", EXPEDITION SHIP TO ANTARCTIC. M.Huruhata and J.Nakamura.
Ann. Geophys., Vol. 14, No. 2, 175-8 (1958).

Observations were made from November 1956 to April 1957, during the voyage from Tokyo to Cape Town and back. The zenith intensities of the 5577 A line were compared with a fluorescent surface of radium paint and were calibrated with the photometer of the Tokyo Astronomical Observatory. The results show that a latitude dependence of intensity seems to exist, the intensity having a minimum around the equator.

551.593.55

954. CALCIUM AND OXYGEN IN THE TWILIGHT AIRGLOW.
A.V.Jones.
Ann. Géophys., Vol. 14, No. 2, 179-85 (1958).

The results of a study of the appearance of Ca II lines in the twilight airglow spectrum made during the summers of 1955, 1956 and 1957 are presented. The appearance of the lines was found to be independent of auroral activity; some indication of the correlation with meteor showers was established. The absolute brightness of the emission in the zenith was found to be 150 R (allowing for atmospheric extinction). The observed absolute brightness is not inconsistent with the supposition that the calcium originates from the debris of meteor trains. The appearance of the 0,1 $^1\Delta_g - ^3\Sigma_g^-$, O_2 band at 1.58 μ in the twilight airglow spectrum as a result of a resonance phosphorescence excited by solar radiation is reported briefly.

551.593.55

955. INTERPRETATION OF TWILIGHT SPECTRA.
J.W.Chamberlain.
Ann. Geophys., Vol. 14, No. 2, 196-203 (1958).

Recent developments in the interpretation of twilight spectra are reviewed. Emphasis is given to the twilight emissions of sodium D and red [OI].

551.594 : 550.385 : 537.543

956. THE STÖRMERTRON. W.H.Bennett.
Ann. Geophys., Vol. 14, No. 2, 206-7 (1958).

The Störmertron is an ion tube in which can be produced accurate scale models of the paths of charged particles in the earth's magnetic field outside of the earth's atmosphere. The principal features of the aurora were simulated and accounted for by using this device as an analogue computer.

551.594.221

957. LIGHTNING MECHANISM AND ATMOSPHERICS RADIATION. H.Isikawa.
J. Geomagn. Geoelect., Vol. 8, No. 4, 136-46 (Dec., 1956).

551.594.52

958. DISPLACEMENTS OF THE RADIANT POINT DURING THE AURORAL DISTURBANCE OF SEPTEMBER 22, 1957. W.N.Abbott.
Canad. J. Phys., Vol. 36, No. 6, 643-8 (June, 1958).

Three detailed photographs of the corona on a well-defined star field, taken during the display of 22 September 1957, render possible determination of the position of the radiant point and measurement of its displacements. The photographs cover an interval of 21 min and the measured displacement, assumed to be continuous, divided by this interval gives an average rate of motion of about 12 minutes of arc per minute of time. The variation of the magnetic elements in the same interval is such as to indicate displacements of the magnetic zenith which, viewed from ground level, appear unrelated to the displacements of the radiant point.

BIOPHYSICS. PHYSIOLOGICAL PHYSICS

578.082

959. RESPIRATOR SUITABLE FOR BOTH SMALL AND LARGE LABORATORY ANIMALS. H.E.Guttmann.
Rev. sci. Instrum., Vol. 29, No. 5, 427-8 (May, 1958).

A respirator with cycling rates from 5 to 80 cycles per minute is described. The inspiration–expiration ratio is adjustable. Four animals may be respirated simultaneously. Operation is quiet, with only one moving part in the multiple valve assembly. Manual operation is possible in event of power failure.

612.843.31

960. DICHROMATISM AND THE MECHANISMS SUBSERVING COLOR VISION. G.A.Fry.
J. Opt. Soc. Amer., Vol. 48, No. 8, 509-12 (Aug., 1958).

In previous papers the writer has formulated a theory of colour vision in which chromaticness is subserved by independent red-green and blue-yellow mechanisms. Each mechanism involves two photosensitive substances. The relative rates of response of these substances for the various wavelengths can be determined from colour mixture and adaptation data for normal observers, and this has been done. The present paper makes use of certain assumptions about the colour mixture data of the tritanope and the luminosity curve of the normal observer to derive the response curves for the four photosensitive substances subserving colour vision.

612.843.31

961. SOME VISUAL FUNCTIONS OF A UNILATERALLY COLOR-BLIND PERSON. I. CRITICAL FUSION FREQUENCY IN VARIOUS SPECTRAL REGIONS.
E.Berger, C.H.Graham and Yun Hsia.
J. Opt. Soc. Amer., Vol. 48, No. 9, 614-22 (Sept., 1958).

612.843.31

962. SOME VISUAL FUNCTIONS OF A UNILATERALLY COLOR-BLIND PERSON. II. BINOCULAR BRIGHTNESS MATCHES IN VARIOUS SPECTRAL REGIONS.
E.Berger, C.H.Graham and Yun Hsia.
J. Opt. Soc. Amer., Vol. 48, No. 9, 622-7 (Sept., 1958).

612.843.63

963. EFFECT OF ORIENTATION ON THE VISIBILITY OF FINE WIRES. J.C.Ogilvie and M.M.Taylor.
J. Opt. Soc. Amer., Vol. 48, No. 9, 628-9 (Sept., 1958).

The visibility of fine wires oriented in eighteen different meridians was investigated. The superiority of the horizontal and vertical meridians is demonstrated.

612.85

964. CREATION OF PITCH THROUGH BINAURAL INTERACTION. E.M.Cramer and W.H.Huggins.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 413-17 (May, 1958).

This paper is an investigation of the phenomenon which was observed by Huggins in 1953. Huggins found that binaural stimulus gives a fairly clear perception of pitch although the separate stimuli to the two ears give no such perception. The basic stimulus consists of white noise introduced into one ear while the same white noise, phase transformed in a narrow band of frequencies, is introduced into the other ear. A practiced subject listening to this stimulus reports a faint pitch quality which is judged to sound about the same as narrow-band filtered noise. A forced-choice technique was used in which six subjects were asked to judge the direction of the pitch change when the frequency band over which the phase shift occurs was changed. The control consisted of the same stimulus presented to the two ears. Data are presented indicating the relationship between the percent of correct judgments and the three experimental variables: frequency, band-width, and intensity level.

612.85

965. SEMANTIC APPROACH TO THE PERCEPTION OF COMPLEX SOUNDS. L.N.Solomon.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 421-5 (May, 1958).

612.85

966. INFORMATION TRANSMISSION WITH ELEMENTARY AUDITORY DISPLAYS. W.H.Sumby, D.Chambliss and I.Pollack.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 425-9 (May, 1958).

Under extremely unfavourable speech-to-noise ratios, special procedures for speech communication may become important. A procedure for transmitting the letters to the alphabet by tone-coded signals was examined in quiet and against a noise background. The procedure employed successive selections, each from among a small number of alternatives, in order to transmit a target vocabulary of 25 letters. Four stimulus variables: tonal frequency, sound level, location, and duration were examined, one at a time. Successive selections were made among two, three and five alternatives per variable. The highest reception rate was obtained with a three-alternative, frequency-coded display. Reception of tone-coded signals in noise was nearly equivalent to that in the quiet, when the tonal signals were about 3 dB above masked threshold.

612.85

967. EFFECT OF THE TRANSMISSION CHARACTERISTIC OF THE EAR ON THE THRESHOLD OF AUDIBILITY. J.Zwislocki.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 430-2 (May, 1958).

The threshold of audibility as a function of frequency is determined by the transmission characteristic of the ear and by the sensitivity of the nervous system. In order to separate the two factors, the sound transmission characteristic is calculated on the basis of known experimental data and compared to the threshold of audibility. As a final result a simple curve is obtained which describes the sensitivity of the nervous system as a function of frequency.

612.85

968. CONFIDENCE RATINGS AND MESSAGE RECEPTION FOR FILTERED SPEECH. L.Decker and I.Pollack.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 432-4 (May, 1958).

The statistical decision model, which has achieved outstanding success in describing the detection of signals in noise was applied to the reception of filtered speech. A confidence rating was added to the articulation test procedure in order to obtain additional information about the listener's criterion of message acceptance and message rejection of filtered speech. The relation between correct confirmations and false alarms — the Receiver Operating Characteristic — obtained with filtered speech corresponds with that typically obtained with noise interference. It is suggested that the "noise" of the decision model may be extended to a wide range of operations which perturb the signal.

612.85 : 534.831

969. TEMPORARY THRESHOLD SHIFT AND MASKING FOR NOISE OF UNIFORM SPECTRUM LEVEL. J.D.Miller.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 517–22 (June, 1958).

This experiment was designed to test the hypothesis that differences in the effective noise level from one critical band to the next can account for the typical audiogram showing the temporary threshold shift which results from an exposure to noise of uniform spectrum level. For equal masking, or $(B + K - \beta_o)$, the greatest losses were found at the highest frequencies and the smallest losses at the lowest frequencies. However, the hypothesis implied that for equal masking all frequencies would show equal losses. Further analysis revealed that when the data for temporary threshold shift were plotted against the quantity $(B + 2.7K - \beta_o)$, the points for all test-tone frequencies fell on a common curve.

612.85 : 534.831

970. TEMPORARY THRESHOLD ELEVATION PRODUCED BY CONTINUOUS AND "IMPULSIVE" NOISES.
W.Spieth and W.J.Trittipoe.
J.Acoust. Soc. Amer., Vol. 30, No. 6, 523-7 (June, 1958).

Three experiments compared the amounts of temporary threshold elevation resulting when a given total amount of noise energy was presented to the ear in the form of repeated, short, intense bursts, and in the form of continuous noise (of much lower maximum intensity). Several patterns of noise bursts were tested, as well as continuous noise. One-millisecond noise bursts and continuous noise, of 20 min duration, were tested most extensively. The most severe impulsive noise tested consisted of 1 msec bursts every 10 msec for 20 min, with a burst SPL of 127 dB or long-time-average level of 117 dB. It appeared quite conclusively that 1 msec bursts of noise have considerably less effect than the equivalent amount of continuous energy on thresholds at 3000, 4000, 6000 and 8000 c/s. Noise bursts of 10 msec, 100 msec, and 1 sec length were tested extensively; it appears that they would cause no more threshold elevation than would the equivalent amount of continuous noise.

612.85

971. MASKING OF ENGLISH WORDS BY PROLONGED VOWEL SOUNDS. J.J.O'Neill and J.J.Dreher.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 539-43 (June, 1958).

One hundred and ten monosyllabic words selected from the Thorndike list of 1000 most frequently occurring words in English to represent equally each of 10 vowels were presented to 300 American listeners in an articulation test. Also tested were 72 spondee words, half selected from those in use in audiological tests and half from those in frequent use in air traffic control, further to represent the same vowel sounds. Masking of the stimuli was accomplished by recording separately each of nine prolonged vowels intoned by a trio of male voices. Results indicate that vowels of equal sound pressure levels differ considerably in masking effectiveness, that words containing a specific vowel are not masked optimally by the same vowel, and that spondees are masked by prolonged vowels in the same rank as are the monosyllables. Prolonged vowel sounds with relatively high concentrations of energy between 700 and 1000 c/s are most effective as masking agents. Rank order correlation of observed masking effectiveness with masking effectiveness predicted by the Strasberg method is 0.52, the Beranek method is 0.59, and by the Pickett–Kryter method, 0.69. Some observations on resistance of words to masking are made in relation to phonemic transition areas within words.

612.85

972. TEST OF PHONEMIC DIFFERENTIATION: THE RHYME TEST. G.Fairbanks.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 596-600 (July, 1958).

Materials are presented for a test of word identification in which the cues for response are confined to the initial consonants and consonant-vowel transitions. Some preliminary results are discussed.

612.85

973. PITCH RATINGS OF VOICED AND WHISPERED VOWELS. G.J.Harbold.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 600-1 (July, 1958).

The problem was to investigate listener judgments of voiced and whispered vowels in an effort to compare relative pitch of voiced and whispered speech. The results indicate, at least for those vowels that showed significant differences, that tonality may not be the sole determinant of listeners' pitch judgments. A comparison of rank orders of the present study and rank order from a previous investigation provided further support to the hypothesis that relative pitch of vowels is not independent of the vowel itself.

612.85 : 534.784

PITCH DISCRIMINATION FOR SYNTHETIC VOWELS. See Abstr. 160

TECHNIQUE. MATERIALS

66.041 : 548.5

974. FURNACE FOR THE GROWTH OF NAPHTHALENE AND ANTHRACENE CRYSTALS. F.R.Lipsett.
Rev. sci. Instrum., Vol. 29, No. 5, 423-4 (May, 1958).

The furnace is for the growth of crystals from the melt by the Bridgman method. Crystals up to 15 mm diam. by 3 ft may be grown. The furnace is simple in construction, and very convenient and reliable in operation.

669.04 : 548.53

MATHEMATICAL TREATMENT OF A TYPICAL ZONE-MELTING PROCESS. See Abstr. 920

669.09

975. CASTING OF ALNICO VII WITH IMPROVED PHYSICAL PROPERTIES. D.H.Wenny and K.M.Olsen.
J. appl. Phys., Vol. 29, No. 3, 504-5 (March, 1958).

Studies in the metallurgical laboratories show that highly purified Alnico VII castings melted under a hydrogen atmosphere are just as brittle as castings air-melted with standard raw materials. On the other hand, silica shell moulds which cut the initial average cooling rate of the castings to about 20 deg C/min afford a convenient way to cast sound crack-free Alnico VII magnets which can withstand the handling and thermal shock of the subsequent heat treating process. Satisfactory magnetic quality and chemical uniformity are obtained by air melting standard raw materials of commercial purity. The magnets are amenable to cutting and grinding and have an excellent surface. Though the moulds are costly, and their fragile nature necessitates careful handling, the use of silica shell moulds will produce an Alnico VII with good magnetic and physical properties.

PHOTOGRAPHY

771.531 : 548.574

ETCHING STUDIES ON PHOTOGRAPHIC GRAINS. See Abstr. 925

778.3

976. A SIMPLE CINEMATOGRAPH ARRANGEMENT FOR THE EXPOSURE OF SOME HUNDRED FRAMES AT A RATE OF 140 000 PER SECOND. H.Bartels and R.Beuchelt.
Z. angew. Phys., Vol. 10, No. 3, 114-17 (March, 1958). In German.

The camera uses a rotating lens and plane mirror, the mirror at half the speed of the lens. The object is imaged on to the rotating mirror, and the rotating lens produces the final image after the light is reflected from an intermediate bank of mirrors formed into a semi-circle. Practical details are given, together with a sample set of photographs.

R.W.Fish

LIST OF JOURNALS

The following list supplements the List of Journals published with the Index to Volume 61 (1958). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free.
The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

J. Elisha Mitchell Sci. Soc.	Journal of the Elisha Mitchell Scientific Society. University of North Carolina, Chapel Hill, North Carolina.
J. Inorg. nuclear Chem.	Journal of Inorganic and Nuclear Chemistry. Pergamon Press, 4 and 5 Fitzroy Square, London, W.1.
Pap. phys. Oceanogr. Met.	Papers in Physical Oceanography and Meteorology. Massachusetts Institute of Technology, Cambridge, Massachusetts; Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.
Tech. J. Brush Group	Technical Journal of the Brush Group. Superseded by: Hawker Siddeley Technical Journal [Hawker Siddeley tech. J.]
Tech. Mitt. Krupp	Technische Mitteilungen Krupp. Fachbücherei Krupp, Postfach 917, Essen.
Z. math. Logik u. Grundlagen der Math.	Zeitschrift für mathematische Logik und Grundlagen der Mathematik. Deutscher Verlag der Wissenschaften, Leipzig.

NEW JOURNAL

Hawker Siddeley tech. J.	Hawker Siddeley Technical Journal. 18 St James's Square, London, S.W.1. Vol. 1, No. 1 dated Winter 1958. Supersedes: Technical Journal of the Brush Group [Tech. J. Brush Group].

ERRATA

Abstr. 1976 (1958) line 3 : for "Yu.A.Alexandrov" read "Yu.A.Aleksandrov".
Abstr. 3849 (1958) line 2 : for "E.A.Heidemann" read "E.A.Hiedemann".
Abstr. 3902 (1958) line 2 : for "E.A.Heidemann" read "E.A.Hiedemann".
Abstr. 7832 (1958) line 5 : for "increasing" read "measuring".
line 9 : for "niolar" read "molar".
Abstr. 8311 (1958) line 5 : for "(Abstr. 4101/1957)" read "(Abstr. 4101/1958)".
Annual Index (1958) p. 869, col. 1 : for "Breazeala,M.A. and Heidemann,E.A." read "Breazeala,M.A. and Hiedemann,E.A."
p. 904, col. 1 : for "Heidemann,E.A." read "Hiedemann,E.A."
p. 983, col. 1 : for "Zankel,K.L. and Heidemann,E.A." read "Zankel,K.L. and Hiedemann,E.A."
p.1002, col. 2, first entry : for "Co, flames, ..." read "CO, flames, ...".

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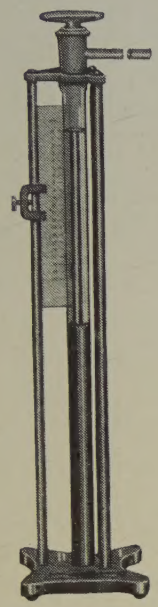

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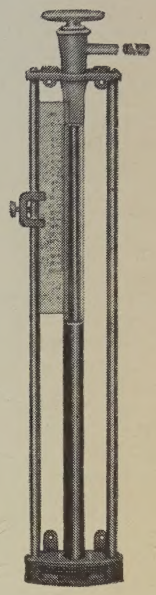

No. 1451H.
Wall Mounting

The Welch-Dubrovin Gauges are made in two basic types. One 9 times and the other 6 times as sensitive as a mercury manometer. Because of this "magnifying factor," the gauge is as sensitive as a manometer which uses a liquid of low density, but has the advantage of using mercury which dissolves very few organic or inorganic vapors and which requires no conversion factor. Unlike mechanical or optical magnifying devices, any small errors due to capillarity, adhesion, etc., are not-magnified. The smallest division on the 9-to-1 type is 0.2 mm and on the 6-to-1 type is 0.5 mm of Hg. Fractions of these values may be estimated. Both types are available with Pyrex-brand or soft glass in either table or wall mounting.

Wall or Table Mountings—0.50 to 20 mm of Hg. Pressure Range—Magnifying Factor 6—Soft Glass or Pyrex Brand Glass—Each $47.50.

Wall or Table Mountings—0.2 to 20 mm. of Hg. Pressure Range—Magnifying Factor 9—Soft Glass or Pyrex Brand Glass—Each $55.00.

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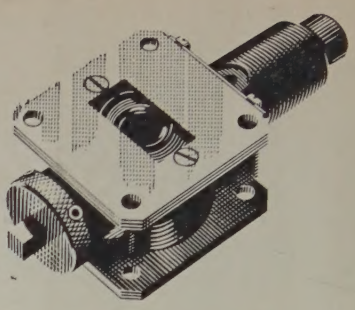
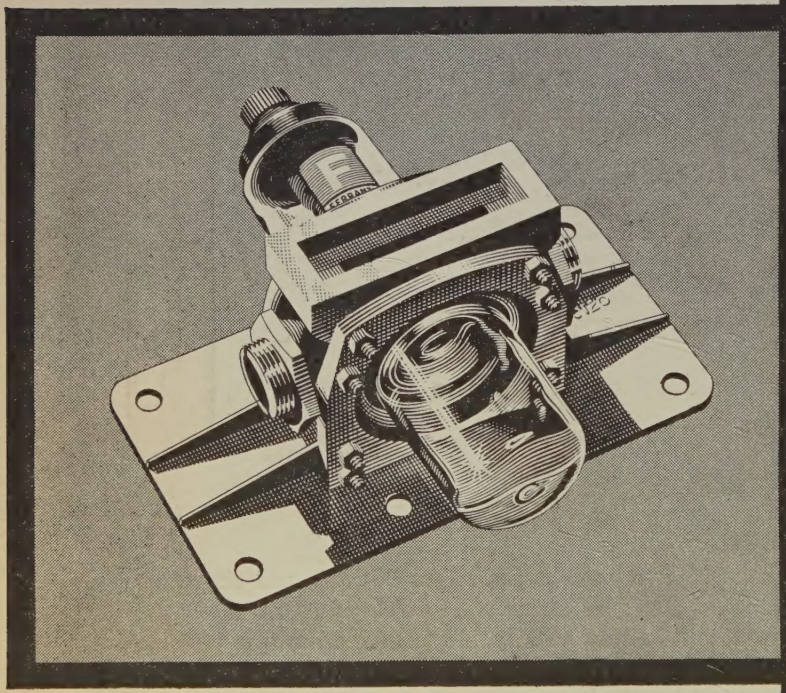
for Radar Equipment





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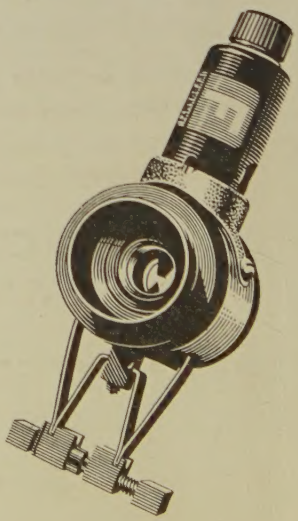

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